ENGINEERING NEWS

AND

AMERICAN RAILWAY JOURNAL.

Vol. XXV. No. 4.

TABLE OF CONTENTS.

Engineering News of the Week 73, 92

Technical Articles:

The Webb System of Hydraulic Buffers (*illustrated*) 74
State Supervision of Potable Water Supplies in New Jersey 74
Cost of Steam Power and Water Power 75
A New Device for Tapping and Connecting Branches to Water Pipes (*illustrated*) 77
Evolution of the Elevator in America 77
Publications Concerning Irrigation in the United States 78
Locomotive Sheds and Locomotive Fire Extinguishers 78
Subaqueous Foundations (*illustrated, concluded*) 79
"Lifts" in England and on the Continent 81
The Qualities Essential for a Free Steaming Locomotive 81
Depositing Dredged Material at the Port of Rouen, France 81
A Library Indicator for Books 81
Hemet Valley Dam, California 86
The Kupferle Hydrant (*illustrated*) 87
Bridge Details, Chicago, Kansas City & Texas Ry. (*with inset*) 87
Census Statistics of Anthracite Production 87
Mr. Worthen's Report on the Chicago Drainage System 87
Two Improvements in Signaling Devices (*illustrated*) 88
Stone Arch at Schuylkill Falls, Philadelphia (*illustrated*) 89
The Water-Works of Gouverneur, N. Y 89
Summary of Meteorological Observations at New York City, 1890 90
Improvement of the Hudson River 90
The Suram Tunnel, on the Trans-Caucasian Railway 91
The Woodlawn Junction Crossing of the N. Y., N. H. & H. and N. Y. & H. Railroads (*illustrated*) 91
Progress on Railway Terminals at Providence, R. I 91

Personals, New Publications, Society Proceedings 81, 88

Editorial Notes 84
The Am. Soc. C. E. Election—Car Service—Rapid Transit by Means of Tunnels for New York City.

Editorials:

World's Fair Prospects 85
The Second Expert Report on the Brooklyn Bridge 85
More New England Wisdom about Car Couplers 86

Correspondence 86
The Brooklyn Bridge Experts' Report—Flush Tanks in San Diego.

Construction News 93–96
Railways, City Transit, Highways, Bridges, Tunnels and Canals, Water-Works, Artesian Wells, Irrigation, Sewerage and Municipal, Electrical, Contracting, Proposals Open, Manufacturing and Technical.

THE GROSS EARNINGS OF RAILWAYS in the United States for the calendar year of 1890, according to figures presented by the *Financial Chronicle* are as follows:

	Gross earnings.			Miles of road end of period.	
	1890.	1889.	Increase	1890.	1889.
	$	$	$	$	$
153 roads full yr.....	589,429,058	544,889,038	44,540,029	103,889	101,367
47 roads 11 mos.....	333,309,224	307,368,643	25,940,581	36,571	36,278
Grand total (200 roads)...	922,738,282	852,257,681	70,480,601	140,460	137,645

The improvement has come from all sections of the country, and considering the low rates and general demoralization in the railway transportation business in certain sections speaks well for the industrial activity of the country. Of the 153 roads which reported for the full year only 11 show any loss, and of the 47 which make returns for 11 months only 2 exhibit a decrease.

Among the roads which have reported for the full year the Atchison stands at the head of the list with a gain of $5,513,848. The Pennsylvania for the eleven months shows a gain of $4,877,759 on the lines east of Pittsburg and Erie, with $4,289,407 more on the Western lines, making over $9,000,000 together. The Union Pacific for the eleven months has $3,756,117 gain and the Baltimore & Ohio $2,005,003. The Northern Pacific for the full year has $2,060,202 increase, the Missouri Pacific, with the Iron Mountain, $1,959,012; the Southern Pacific, $1,900,091; the Great Northern, $1,741,115; the Chesapeake & Ohio, $1,558,769; while on the East Tennessee, the Louisville & Nashville, the Canadian Pacific, the Richmond & Danville, the Norfolk & Western and the Lake Shore the increase ranges from one to one and one-third million dollars. For the eleven months the Burlington & Quincy, the Erie, the Reading and the Chicago & Northwest all have either close to one and one-half millions gain or in excess of that amount.

THREE DECAPOD ENGINES which are being built for the Chicago, Burlington & Quincy R. R. by the Rogers Locomotive & Machine Works, of Paterson, N. J., are an evidence of the tendency to increased weights of locomotives which was pointed out in the articles on bridge loads in our issue of Jan. 10. The Erie specifications are for a load of 161,000 lbs., and the engines above referred to have a weight of about 150,000 lbs. on the driving wheels, and have no truck. The engines are for heavy work on mountain grades. Cylinders, 22 × 28 ins; driving wheels, 50 ins. diameter. The boiler is straight, 68 ins. diameter; the fire box is of the Belpaire type, 11 ft. long, 60 ins. wide at the crown and 41 ins. wide at the grate. There are 229 tubes, 2¼ ins. diameter and 14 ft. 6 ins. long. Grate area, 37 sq. ft. Heating surface, 2,370 sq. ft. The tender is carried on 33-in. wheels, and the tank has a capacity of 3,480 galls. Air brakes are fitted to all driving and tender wheels.

THE METROPOLITAN UNDERGROUND RAILWAY CO. has been organized to build a tunnel between the foot of Whitehall St., in New York, and the foot of Atlantic Ave., in Brooklyn. The list of incorporators include some of the strongest and best known business men in the two cities, and among these may be noted AUSTIN CORBIN, B. F. TRACY, Gen. JOHN NEWTON, ABRAM S. HEWITT, E. NORTON, F. P. OLCOTT, W. B. DICKERMAN, LEVI P. MORTON, JOHN SLOANE, CALVIN S. BRICE, C. P. HUNTINGTON, etc. This array of names and capital looks very much like business, to start with. This organization is the first step in a very extensive scheme for rapid transit in New York, and, provided their plans are acceptible to the Rapid Transit Commission, now sitting, and to whom they have been presented, the tunnel would be extended under New York to Jerome Park, and another tunnel would connect Brooklyn with Jersey City, under the North River and on a line with the Battery. As proposed, the total length of tunnel would be more than 42 miles, and involve an expenditure of $60,000,000. It would be located about 100 ft. below the surface; be double track and provided with stations and all appliances for the rapid handling of passenger traffic.

It is stated that $30,000 has been spent in preliminary investigation, by borings, etc. They find that at from 90 to 110 ft. below the curb line of streets the whole 42 miles of tunnel would be in solid rock, excepting about 2,410 ft. under the North River and a narrow space at Canal St., in this city. The Brooklyn tunnel, on which it is proposed to begin work as soon as possible, would be 6,050 ft. long, with 5,000 ft. between stations. The underground stations would be 330 ft. long, 60 ft. wide and 30 ft. high, with a shaft 17 × 80 ft. for six elevators of a combined capacity of 340 people per minute. Passengers would be landed in the center of the underground platform. The tunnel itself would be 26 ft. wide by 20 ft. high and be lined with brick in cement. Ventilation would be secured by large iron pipes at the roof, with openings at every 50 ft., and two large centrifugal fans drawing air from the center of the tunnel. In New York 3 of the elevators would ascend to the level of the elevated roads. The Long Island R. R. passengers would probably be run through this tunnel to New York. The fare would be 3 cts., or 10 tickets for 25 cts., between New York and Brooklyn. The North River tunnel may include connection with freight train tracks, to be run in slack hours. The cost of actual tunnel construction, aside from real estate, stations, elevators, track and rolling stock, is estimated at $1,250,000 per mile.

THE POUGHKEEPSIE BRIDGE CO., through its president, Mr. JOHN S. WILSON, has published a statement of its financial condition. It appears that since the opening of the bridge in Sept., 1889, it has not earned its full fixed charges. Outside the operating expenses, which are small and all paid, these fixed charges amount to 6% interest on $5,000,000 coupon bonds. The business of the bridge, however, is constantly increasing. During the month of Sept., 1889, 52 loaded freight cars passed over; in Nov., 1889, 92 cars passed, while in Nov., 1890, the number of loaded cars using the bridge was 2,368. President WILSON says there appears to be a general disposition in favor of a compromise among the bond holders, and avoid a receivership by the issue of interest in scrip until the income has increased the necessary amount.

JETTIES ARE TO BE BUILT to improve the harbor of Coatzacoalcos, in Campeche Bay. A Dallas, Tex., dispatch says that Messrs. J. F. CONNER, JOS. LAING, E. K. SMOOT, and F. O. BROWN, of that city, have obtained from the Mexican Government a concession to build two jetties, each 5,500 ft. long. The price to be paid is $2,000,000, and a bonus of $150,000 if the work is finished in 9 months. The jetties are to be built of rows of treated wooden piling, driven sand-tight, and packed within with sand. So says the dispatch, but unless the timber is treated to resist the teredo, which abounds in those waters, the Mexicans are either going to pay dearly for a structure of doubtful durability, or there is some mistake about the figures.

THE DETROIT RAILROAD & TUNNEL CO. is again at work attempting to secure the passage of a bill for a tunnel under the Detroit River. The bill has passed the House, but hangs in the Commerce Committee of the Senate.

LATE SURVEYS FOR THE PROPOSED CHANNEL BRIDGE have brought out some interesting points. Soundings and borings were taken from July to September last. From these M. RENAUD reports to the French Minister of Marine that the best line is a straight one extending from a point near the South Foreland light on the English side, and terminating near the tunnel entrance at Cape Grisnez. The length of this line is 20.74 miles. The greatest depth of water on the line is not quite 170 ft. and this extreme depth extends over a length of only about one mile. The length of the bridge on this route is shorter by 3.2 miles than by the line shown on the late plans issued, and water 180.4 ft. deep is avoided. The soundings show that the submarine soil is solid everywhere and that there is no mud or soft clay. As a result of the new survey the piers could be reduced in height, and there would be 92 piers instead of 112. Of the 92, 17 would be in depths of from 98 to 131 ft.; 31 would be in 131 to 164 ft. of water. The above items are taken from the London *Railway News*.

THE VLADIKAVKAS-TIFLIS RAILWAY now under construction across the Caucasus Mountains will be about 116 miles long and have several loops, according to the "Iswestija Ssobranija Putej-Ssobschtschenija," as the St. Petersburg Railway Club is euphoniously called. Three lines have been proposed for the summit division; one has a tunnel 2.91 miles long at an elevation of 6,080 ft., the second has a tunnel of 7.28 miles at an elevation of 5,280 ft., and the third tunnel, 9.02 miles long, is at an elevation of 5,050 ft. The maximum grade on tangents would be 2.4%, in tunnels 1%, in each plan. As far as we can learn the summit locations and tunnel are yet under discussion.

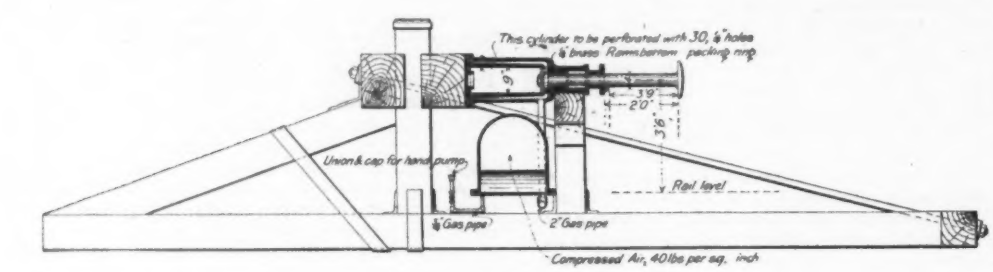
THE MONIER SYSTEM of arch construction was recently tested in Budapest, with very satisfactory results. Two arches of similar dimensions, 8.69 ft. long, 0.87 ft. rise and 2 ins. thickness at crown, one of the best quality of concrete and the other on the Monier system, were loaded until rupture took place. The concrete arch broke completely under a load of 371 lbs. per sq. ft., while the other began to sink, without breaking however, only when loaded up to 1,917 lbs. per sq. ft.

THE ELECTRIC RECIPROCATING ENGINE, described by its inventor, Mr. C. J. VAN DEPOELE, in our issue of Oct. 4, is having its applicability to various reciprocating machines carefully tested at the laboratory of the Thomson-Houston Co. Among the machines which it is proposed to introduce is a power hammer. It will be remembered that in the electric reciprocating engine an iron bar is alternately pushed out of and drawn into the interior of a cylindrical coil of wire. In the Van Depoele hammer, as described in the *Electrical Engineer*, the reciprocating movement is continued all the time, but by directing the current to the upper or lower parts of the coil, the hammer bar is made to strike upon the anvil or to end its stroke some distance above it. Thus the flow of the current and the reciprocation of the hammer goes steadily on, the operator only raising or lowering the position of the hammer by moving a lever similar to that used for a steam hammer. It seems hardly possible that this machine could displace the larger class of steam hammers; but it may very likely prove to be especially adapted to light, quick-running hammers, now driven by a crank or by a cam movement.

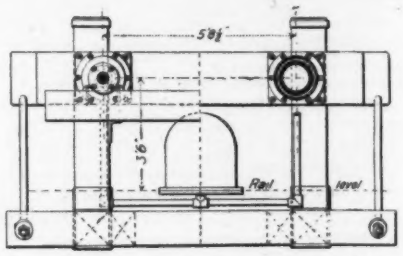
The Webb System of Hydraulic Buffers.

The accompanying cuts show the general features of a hydraulic buffer stop invented by Mr. F. W. WEBB, Mechanical Engineer of the London & Northwestern Ry., and used with much success on that road.

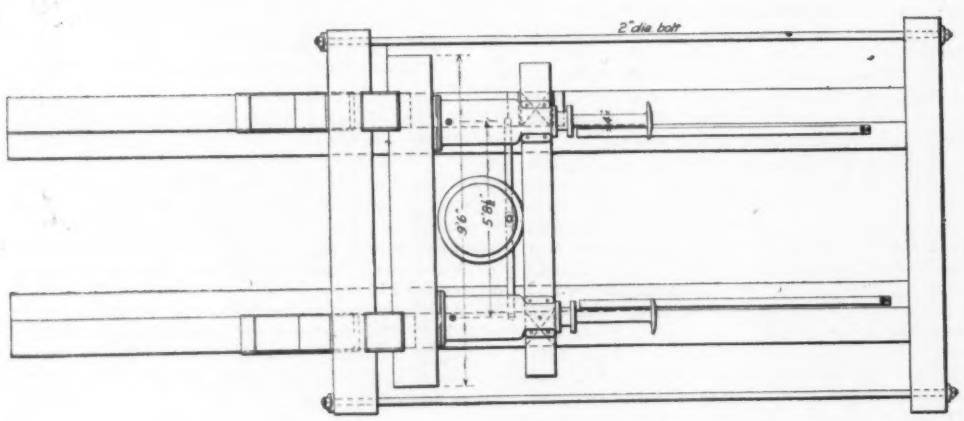
The buffer heads in this device are simply forged to piston rods working in hydraulic cylinders in such a manner that a train striking them will be brought to a stop without any recoil. The cylinder in which each piston works is placed within a larger cylinder or casing, with a space of about 1¼ ins. between them. One end of the small cylinder is open, so that the piston head, which is solid, is free to travel the whole length of the outer cylinder. The body of the inner cylinder is perforated from end to end with small holes, so that as the piston is pushed in the holes through which the liquid escapes become fewer and the resistance is gradually increased, the liquid being forced into a vessel in which the air is under a pressure of 45 lbs. per sq. in. when the buffers are in their normal position.



Side Elevation.



End Elevation and Section.



Plan.

WEBB'S HYDRAULIC BUFFER STOP.

The liquid used is a mixture of petroleum, soap and water, insuring a good lubrication of the parts at all times. The piston, which is 9 ins. in diameter and of 2-ft. stroke, is fitted with steel Ramsbottom packing rings to make it practically tight. The piston rod is of steel, 4 ins. in diameter, with the buffer head forged solid, and works through a stuffing box in the outer casing, the piston head being secured after the rod is in position.

When the buffers are in continual use the pressure in the air vessel will remain unaltered for about 6 months, but should it drop, owing to any leaky joint, it is easily restored by means of a small hand pump.

In tests made on buffers of this type at Rugby, the pressure in the air chamber with the pistons out was 45 lbs., with the pistons in, 75 lbs. Two pairs of buffers connected to one chamber caused a pressure of 155 lbs. when driven into the casings. The pressures depend upon the quantity of air in the chambers before pumping. When the buffers were forced up by an engine and 8 coaches at about 3 miles an hour, the pressure in the inner cylinder rose to about 350 lbs.

State Supervision of Potable Water Supplies in New Jersey.

In his last message to the State Legislature of New Jersey Gov. LEON ABBETT calls attention to the above named subject in the words given below. The question is a very important one to the urban population of New Jersey, and in its general bearings is of no little interest to the engineering profession. Gov. ABBETT speaks as follows:

The question of the conservation and control of the potable waters of the State for the purposes of public water supply to cities and towns is of far reaching interest and importance to every center of population, present and prospective, within its limits, and has attracted the attention of the Legislature from time to time, as is attested by the water legislation of the past fifteen years.

It is the duty of the State to act in this department as the guardian of the interest of all of its citizens. The waters of the State are a portion of the public domain, held by it as a trustee for the use of the public, and legislation regarding them has been based upon this theory. The doctrine of the common law, which denies to riparian proprietors any actual property, or any ownership whatever, in the water of streams, has been affirmed by repeated decisions. Claims have, however, been recently made, and thought to be upheld by legislation and by the acquisition of alleged vested rights in the waters of certain of the non-tidal rivers of the State, to a distinct property right in running water, treating it as a chattel which may be conveyed from place to place within or beyond the boundaries of the State and sold or disposed of as a commodity.

The physical geography and configuration of the State are such that abundant sources of the purest water are found among the hills and mountains of the northern counties, at an elevation sufficiently great to enable it to be economically distributed by gravitation alone, to almost, if not all, the cities and towns of the State by the adoption of a comprehensive State water supply. Such a system would effect a great saving in cost and an equal gain in efficiency of service and purity of quality over the method of separate supplies from local sources. Steps should be taken by the Legislature looking to the elaboration of such a plan as contemplated by the creation of the State Water Commission in 1882. The work done by that body covered only the northeastern portion of the State, the plans for which were presented in the report of the Commission in 1884, since which time no work has been done.

Until a complete system for the whole State is formulated, protection should be afforded by the Legislature to the smaller communities against any attempted exclusive occupation by single cities, in excess of their reasonable demands, of valuable sources of water supply.

The right of the State to stop any act which would diminish the flow of any stream of potable water from points within to places without the State to the injury of our communities, should be carefully guarded.

Those familiar with the subject are aware that in sections of the State the water rights of almost every stream available for water supply have been secured by one or another large corporation, with the evident aim of obtaining a complete monopoly and rendering all the cities and towns, which eventually must be supplied from these sources dependent upon the companies for their supply.

While the water rights are in small holdings a city or town can obtain a supply from almost any available source by the purchase of water rights from individual owners, and if satisfactory bargains cannot be made then the water can be secured by the right of eminent domain, which is generally granted by the State legislature in the act enabling the city or town to build new or extend existing works. The situation is far different after a large corporation has brought within its control the water rights of a large section, for then the rights can, if desired, be held at such a price that no city can afford to purchase them outright, and when an attempt is made to secure authority to exercise the right of eminent domain a strong corporation maintains its lobby at the legislature to prevent the securing of such authority; in fact, it goes further and uses its influence at the polls to the end that legislators favorable to its plans may be elected.

As stated by Gov. ABBETT, a State Water Commission was appointed in New Jersey in 1882 to investigate the sources of water supply within the State, and to formulate a plan or plans by which the water supply of the various municipalities might be kept pure and might be furnished at the lowest cost, both ends to be attained by a combination of municipal interests. The commission investigated the water supply of the northeastern portion of the State, and reported in 1884. Nothing has been done since. Have corporations with large water interests done anything to prevent further action, or were the further labors of a commission unnecessary? Evidently not the latter, at least in Gov. ABBETT's opinion: The commission submitted a plan providing for a joint water supply to the district embraced in Hudson, Essex and Union counties, and the cities of Paterson and Passaic in Passaic Co. This district included Jersey City and Newark, and a total population of 480,000, census of 1880, or 42% of the population of New Jersey. The plan was given in outline in our issue of April 12, 1884.

Since the above State Commission's report was published the East Jersey Water Co. and allied corporations have secured and united large water interests at the headwaters of the Passaic, and are now building large storage reservoirs in the Pequannock drainage basin, and constructing a large conduit to supply, first of all, Newark. These works were described in our issue of Oct. 11, 1890. It is stated that the works now under construction will have a sufficient capacity to supply not only Newark but also Jersey City and other adjacent towns for some ten years to come; and, by the terms of the contract with Newark, all water above 27,500,000 galls. per day can be sold by the East Jersey Water Co. for 11 years after the completion of the works. At the expiration of this period Newark pays another $2,000,000, making $6,000,000 in all, and has a guaranteed daily supply of 50,000,000 galls., and be-

comes the owner of the Pequannock system of reservoirs and the conduit from them to the city.

In 1890 a move was made to introduce a bill into the Legislature which would give Jersey City and other towns the right to obtain under eminent domain a water supply from the above mentioned sources. The movement was stopped before such a bill was introduced. It is to be hoped that Gov. ABBETT's recommendations will be carried out and the State Water Commission be revived and resume its good work, for the people of New Jersey should at least be made aware of the possibilities and probabilities of water supply development within their State.

Cost of Steam Power and Water Power.

A point on which technical literature is generally defective is the matter, of great importance to a practicing engineer, of costs and prices. The chief reasons for this are that particulars of cost are difficult to obtain and difficult to arrange in such a manner as to be useful for engineers engaged in the design of similar work, and that they soon go out of date with the fluctuations in prices which are continually going on. The matter of power, taking one industry with another, is probably the most important with which modern engineering has to do. Yet in all the enormous mass of literature relating to the steam engine, the water wheel, and other prime movers, an engineer will find very meagre information as to the actual cost year in and year out of driving a mill or factory by water or by steam.

This is a defect the more important in view of the revival at the present day of the use of water-power, which has come about by reason of the application of electricity to distribute the power from the place of generation to the place of use. The most valuable paper on this topic with which we are acquainted is one read before the American Society of Mechanical Engineers, at the New York meeting in 1889, by Mr. CHAS. T. MAIN, Superintendent of the Lower Pacific Mills, at Lawrence, Mass. Through an oversight the paper was not republished in ENGINEERING NEWS at the time of its presentation; but its importance and convenience for reference is such that we have determined to give space to it now.

For additional matter on water-power at New England's chief manufacturing centers, reference may be made to a paper by DESMOND FITZGERALD in ENGINEERING NEWS of May 25 and June 1, 1889.

The costs of power which follow have been worked out per indicated horse power on engine, and per horse power on wheel shaft. These two are comparable, for the friction of engine will be about equal to the friction of gears and shafting on water wheels.

I. COST OF STEAM POWER.

Let us first consider the cost of steam power, and we shall find that its cost will vary through a number of causes, which are principally the cost of fuel in different localities; the amount of exhaust steam used for various purposes after passing it through the engine and there producing power; the amount of power required and the type of engine used.

In order to cover all the variable quantities in our problem, Table I. has been prepared, which shows the approximate cost of steam power in amounts varying from 500 to 2,000 HP., with the high pressure, condensing and compound engine, using different per cents of exhaust steam for heating purposes, and various prices of coal.

The methods used in working out this table are fully explained by working through for a 1,000 HP. plant, using an average of 25% of exhaust steam for heating purposes, with coal at $5 per long ton delivered in pocket.

Let use assume, in the plant of 1,000 I. HP., that the engines for each case are a pair of tandem compounds, a pair of single cylinder condensing, and a pair of non-condensing engines.

The items of cost for running such plants are fuel, attendance of engines and boilers, oil, waste and supplies, depreciation, repairs, interest, taxation, and insurance.

The total fuel consumption per I. HP. per hour is shown in Table IJ The total consumption per I. HP. per hour is the total amount burned, and is the amount to be charged to power if no exhaust steam is used for heating purposes. The net consumption per I HP. per hour is the amount to be charged to power after deducting a weight equivalent to the amount of exhaust steam used for heating purposes.

The conditions for running are assumed as follows: The compound engine is to run with 100 lbs. initial pressure above the atmosphere; the receiver pressure to be 5 lbs. The condensing engine to have an initial pressure of 80 lbs.; and if a portion is run high pressure, that portion is to exhaust against 5 lbs. back pressure. The high pressure engine is to run with an initial pressure of 100 lbs., and to exhaust against a back pressure of 5 lbs. The temperature of feed water is taken at 100° Fahr.

The coal consumption per I. HP. per hour, when the engines are running with steam used for power only, are taken as 1¾ lbs. for the compound; 2¼ lbs. for the condensing and 3 lbs. for the high pressure engines, and these figures will be conceded by engineers in general to be fair values to work with for the best constructed engines and boilers for each type.

TABLE I.—SHOWING APPROXIMATE TOTAL YEARLY EXPENSE OF STEAM POWER PER I. HP.

Engine.	I. HP. of plant	Steam used for power only. Cost of coal per ton. $3.00	$4.00	$5.00	$6.00	25% of exhaust steam used. Cost of coal per ton. $3.00	$4.00	$5.00	$6.00	50% of exhaust steam used. Cost of coal per ton. $3.00	$4.00	$5.00	$6.00	75% of exhaust steam used. Cost of coal per ton. $3.00	$4.00	$5.00	$6.00	100% of exhaust steam used. Cost of coal per ton. $3.00	$4.00	$5.00	$6.00
Compound.	500	22.35	24.8'	27.28	29.74	20.73	22.84	24.95	27.06	19.10	20.86	22.62	24 38	17.42	18.83	0.24	21 65	.....	.....	.....	.....
	1,000	19.16	21.63	24.09	26.55	17.57	19.68	21.79	23 90	15 99	17.75	19.51	21.27	14.34	15.75	17.16	18.57	.....	.....	.....	.....
	1,500	17.38	19.84	22.30	24.76	15.81	17.92	20.03	22.14	14.23	15.99	17.75	19.51	12.62	14.03	15.44	13.85	.....	.....	.....	.....
	2,000	16.23	18.69	21.15	23.61	14.73	16.84	18.95	21.06	13.18	14.94	16.70	18.46	11.66	13.07	14.48	15.89	.....	.....	.....	.....
Condensing.	500	24 83	28.35	31.87	35.39	22.03	24.93	27.83	30 73	19.06	21.36	23.06	25.9*	16 28	17.96	19 64	21.32	.....	.....	.....	.....
	1,000	22.34	25.81	29.36	32.88	1 .54	22.44	25.34	28.24	16 62	18.92	21.22	23.52	13.87	15.54	17.22	18 90	.....	.....	.....	.....
	1,500	21 01	24.53	28.05	31.57	18.81	21.71	24.61	27.51	15.28	17.58	19.88	22.18	12.48	14.16	15.84	17.52	.....	.....	.....	.....
	2,000	20.13	23.65	27.17	30.69	17.93	20.83	23.73	26.63	14.40	16.70	19.00	21 30	11.60	13.28	14.96	16.64	.....	.....	.....	.....
High pressure.	500	27.16	31.39	35.62	39.85	23.64	27.06	30.50	33.94	20.07	22.72	25.37	28.02	16.47	18.32	20.17	23.02	12.89	13.95	15.01	16.07
	1 000	24.82	29.03	33.25	37.48	21.26	24.70	28.14	31 58	17.72	20.37	23.02	25.67	14.16	16.01	17.86	19.71	10.54	11.60	12.06	13.72
	1,500	23.69	27.92	32.15	36.38	20.16	23.60	27.04	30.48	16.59	19.24	21.89	24.54	13.06	14.81	16.76	18.61	9 38	10 44	11.50	12.56
	2,000	22.79	27.02	31 25	35.48	19.26	22.70	26.14	29.58	15.69	18.34	20.99	23.64	12.16	14.01	15.86	17.71	8.48	9 54	10 60	11.66

TABLE II.
SHOWING GROSS AND NET COAL CONSUMPTION IN LBS PER INDICATED HORSE POWER PER HOUR.

Column 1.	2	3	4	5	7
Engine.	Compound.		Condensing.		[illegible]gh pressure.
Per cent. of exhaust steam used for heating purposes.	Lbs. of coal per I. HP. per hour, all coal charged to power.	Lbs. of coal per I. HP. per hour, deducting amount equivalent to exhaust steam used.	Lbs. of coal per I. HP. per hour, all coal charged to power.	Lbs. of coal per I. HP. per hour, deducting amount equivalent to exhaust steam used.	Lbs. of coal per I. HP. per hour, all coal charged to power.	Lbs. of coal per I. HP. per hour, deducting amount equivalent to exhaust steam used.
0	1.75	1.75	2.50	2.50	3.00	3.00
25	2.06	1.50	2.63	2.06	....	2.44
50	2.38	1.25	2.75	1.63	....	1.88
75	2.69	1.00	2.88	1.19	....	1.31
100	....	....	....	....	....	0.75

The explanation of Table II. is as follows.

When steam is used for power only, the coal consumption is shown at the head of each column.

In column 2 is given the gross consumption per I. HP. for the compound engine, which is found thus: Supposing 25% of the steam exhausted from the high pressure cylinder is taken from the receiver, then 75% of the whole steam admitted to high pressure cylinder will be used as in a regular compound, and 25% of the steam admitted will be used as in a high pressure engine, and the total consumption will be

$$1.75 \times .75 = 1.31$$
$$3.00 \times .25 = .75$$
$$2.06$$

and so on for each per cent. taken from receiver.

Column 4 is obtained in a similar way to column 2.

In column 3 is given the net weight to charge to power. For the compound engine it is obtained thus: Starting at 100° temperature of feed, the amount of heat necessary to make 1 lb. of steam at 100 lbs. will be 1 117 thermal units.

The amount of heat necessary to produce 1 lb. of steam at 5 lbs. pressure from 100° Fahr. is 1,083 thermal units.

The amount of heat to charge to power if the steam is admitted at 100 lbs pressure, and exhausted and used at 5 lbs. pressure, will be 1,117 − 1,083 = 34 T. U. per lb. of steam, or 34 ÷ 1,117 = .0307 of the total amount admitted.

Besides the change of about 3%, due to the difference in pressure at the beginning and end of stroke, we must consider the effect of cylinder condensation, and condensation in the jackets. These are rather indefinite quantities, and will seriously affect the amount of coal to be charged to power. The difference in the amount of condensation by passing the steam through an engine, or passing it through pressure regulators and pipes, should be charged to the power. Let us assume that 20% of the steam apparently evaporated passes from each cylinder in the form of water, and that 5% of the total weight of steam used is condensed in the jackets, making a total loss by condensation of 25%. This may be rather high, but I have placed it high enough to cover possible losses by condensation. This added to 3%, the amount of heat due to the difference in pressures, makes a total loss of 28%. If we call the loss by condensation in pipes and by passing through regulators 3%, we shall have a difference or net charge of 25% to make to the engine or to power.

We get, then, the amount of steam to charge to power for the compound engine, 25% being taken from the receiver; thus

$$1.75 \times .75 = 1.3125$$
$$3.00 \times .25 \times .25 = .1875$$
$$1.50$$

and so on for each per cent. token from the receiver.

Columns 3, 5, 6 and 8 are obtained in a similar way.

If it is necessary to make steam for other purposes than power, and if this steam can be passed through the engine before being used for other purposes, then all the expense that should be charged to power is the weights of coal which we have in columns 3, 5, 6 and 8, Table I., a portion of the attendance on boilers, and a portion of the cost of boiler plant for depreciation, repairs, interest, taxation and insurance, this portion being in the same ratio to the full cost of attendance and depreciation, repairs, etc., of the boiler plant as the weight of coal charged to the engine is to the gross weight consumed. To this add the full cost of attendance of engine, full cost of oil, waste

TABLE III.—SHOWING ORDINARY RUNNING DAILY AND YEARLY EXPENSES. 1,000 HP. PLANT.

Col. 1.	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Per cent. of exhaust steam used.	Lbs. coal per I. HP. per hour.			Cost of coal per I. HP. per day of 10¼ hours at $5 per long ton—2,240 lbs.			Attendance of boilers per I. HP. per day.			Attendance of engine per I. HP. per day.			Oil, waste and supplies per I. HP. per day.			Total daily expense.			Total yearly expense—308 days.		
	Compound.	Condens'g.	High Pressure.	Compound.	Condens'g.	High Pressure.	[illegible]pound.	Condens'g.	High Pressure.	Compound.	Condens'g.	High Pressure.	Compound.	Condens'g.	High Pressure.	Compound.	Condens'g.	High Pressure.	Compound.	Condens'g.	High Pressure.
				c.	c.	c.	c.	c.	c.	c.	c.	c.	c.	c.	c.	c.	c.	c.	$	$	$
0	1.75	2.50	3.00	4.00	5.72	6.86	0.53	0.75	0.90	0.6[illegible]	0.40	0 3[illegible]	0.25	0.22	0.20	5.38	7.09	8 31	16.570	21.837	25.565
25	1.56	2.06	2.44	3.43	4.71	5.58	.45	.62	.73	.60	.40	.25	.25	.22	.20	4.73	5 95	6.86	14.568	18.326	21.129
50	1.25	1.63	1.88	2.86	3 73	4.30	.38	.49	.56	.60	.40	.35	.25	.22	.20	4.09	4.84	5.41	12.597	14.97	16.663
75	1.00	1.19	1.31	2.29	2.72	3.00	.30	.36	.39	.60	.40	.35	.25	.22	.20	3.43	3.72	3.94	10.564	11.458	12.135
100	....	....	0.75	....	....	1.72	....	....	.23	....	....	.35	....	....	.20	....	....	2.50	.....	.....	7.700

TABLE IV.—Showing Cost of Plant per I. HP. to Charge to Power. Also Depreciation, Repairs, Interest, Taxation and Insurance per I. HP. per Year. Also Total Yearly Expense per I. HP.

Column 1.	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Engine.	Per cent. of exhaust steam used.	Engine and piping complete.	Engine house.	Engine foundations.	Total cost of engine plant.	Depreciation @ 4% on total cost.	Repairs @ 2% on total cost.	Interest @ 5% on total cost.	Taxation @ 1.5% on ¾ cost.	Insurance @ 0.5% on engine and engine house.	Totals of cols. 7, 8, 9, 10 and 11.	Boilers complete, including feed pumps, etc.	Boiler house.	Chimney and flues.	Total cost of boiler plant.	Depreciation @ 5% on total cost.	Repairs @ 2% on total cost.	Interest @ 5% on total cost.	Taxation @ 1½% on ¾ cost.	Insurance at 0.5% on total cost.	Totals of cols. 17, 18, 19, 20 and 21.	Total ordinary running expense, cols. 20, 21 and 22, Table III.	Total yearly expense per I. H. P., cols. 12 + 22 + 23.
Compound	0	$25.00	$8.00	$7.00	$40.00	$1.60	$0.80	$2.00	$0.45	$0.165	$5.015	$9.33	$2.92	$6.11	$18.36	$0.918	$0.367	$0.918	$0.207	$0.092	$2.502	$16.570	$24.087
"	25	Constant.	:	:	:	:	:	:	:	:	:	8.00	2.50	5.66	16.16	.808	.323	.808	.182	.081	2.202	14.568	21.785
"	50											6.67	2.08	5.15	13.90	.695	.278	.695	.157	.070	1.894	12.597	19.506
"	75											5.33	1.67	4.60	11.60	.580	.232	.580	.131	.058	1.581	10.564	17.160
Condensing	0	20.00	7.50	5.50	33.00	1.32	0.66	1.65	0.371	0.138	4.139	13.33	4.17	7.30	24.80	1.240	.496	1.240	.279	.124	3.379	21.837	29.355
"	50	21.00	7.50	5.50	33.00	1.32	0.66	1.65	371	138	4.139	10.99	3.43	6.70	21.12	1.056	.422	1.056	.238	.106	2.878	18.326	25.343
"	25	19.00	7.50	5.00	31.00	1.26	0.63	1.575	354	133	3.952	8.69	2.72	5.92	17.33	.867	.347	.867	195	.086	2.362	14.907	21.221
"	75	19.90	7.50	5.00	31.00	1.26	0.63	1.575	354	133	3.952	6.35	1.18	4.92	13.25	.663	.265	.663	.149	.066	1.806	11.458	17.216
Non-condensing	0	17.50	7.50	4.50	29.50	1.18	0.59	1.475	0.332	0.125	3.702	16.00	5.00	8.00	29.00	1.450	.580	1.450	.326	.145	3.951	25.595	33.248
"	50											13.01	4.07	7.20	24.28	1.214	.486	1.214	.273	.121	3 308	21.129	28.139
"	25											10.03	3.13	6.30	19.46	.973	.392	.973	.219	.097	2.654	16.663	23.019
"	75											6.99	2.18	5.30	14.47	.724	.289	.724	.163	.072	1.97⁹	12.185	17.859
"	100	Con-stant.	:	:	:	:	:	:	:	:	:	4.00	1.25	4.00	9.25	.463	.185	.463	.104	.046	1.361	*7.700	12.663

and supplies for engine, and full cost of engine plant for depreciation, repairs, etc.

This is shown in Tables III. and IV.

COST OF WATER POWER.

The variation in the cost of water power plant per horse power is very great. This variation is caused principally by the following reasons: First, the variation in head in different localities, and unless the fall is between two canals the head is variable for a specified place, and therefore influences the size of plant necessary. Second, the distance from source of supply to point of discharge is an element which very materially affects the cost of plant.

The variation in total cost of water power will depend then principally upon the charge made for water and the cost of plant per unit of power.

The average estimated cost per HP. on wheel shaft for three separate plants in Manchester, N. H., of 800 HP. each and very nearly identical in construction, where the average distance from canal to river is about 30 ft. and the average head 30 ft., is $44. As these all discharge into the river they must either be about one and a half times the capacity required at average head, or a portion of the mill will be stopped many days during the year, in times of freshets when the head is reduced; and it will be stopped some days even if the capacity at average head is one and a half times the average power required. The cost then of these plants will be $44 × 1½ = $66 per HP. required.

In Lowell, Mass., in one mill there are two plants, where the average distance from supply canal to discharge canal is about 575 ft. and the fall is 13 ft. The estimated cost per HP. for a modern plant is about $110. The power of each plant would be about 1,000 HP. As the discharge is into a canal the head is nearly uniform throughout the year.

On another corporation in Lowell there are four distinct plants, all delivering from canal to river under an average head of 18 ft. The average distance from canal to river is about 290 ft. The estimated costs of four modern plants under the same conditions average about $57 per HP. All of these are subject to back water and the plants must be of one and one-half times the power required, and, in fact, the plant at this corporation is two-thirds greater capacity at average head than the average power used.

The estimated cost of one plant in Lawrence, Mass., where the average head is 28 ft. and the distance from canal to river 400 ft., is $42 per HP. of plant, or $42 × 1½ = $63 per HP. used.

In 1887 there were 25 days when the wheels would develop only two-thirds or under of the power at 28 ft. head in Lawrence, and for the year ending May 1, 1888, there were 38 days at Lowell when some of the wheels were running under similar conditions. During the year 1888 the number of days when the power was greatly reduced was even more than in 1887.

From the above it will be seen that no established cost can be made for a water power plant, even in the same place when the conditions differ, and that the cost per HP. on wheel shaft may easily vary from $50 to $100 and, therefore, that each case must be treated by itself.

The items which go to make up the total cost of a plant in Lawrence, North Canal, for a 1,000 HP. plant are about as follows:

Ice guards, racks and head gates	$3.50
Iron penstocks	8.50
Wheels (flume pattern), including gears and shafting	10.00
Wheel pits	8.00
Raceways	15.00
	$45.00

$45 × 1½ = $67.50 per HP. used.

Table V. shows the approximate cost per HP. on wheel shaft for a 1,000 HP. plant under different heads and different distances from supply to discharge, where no great obstacles to construction exist.

TABLE V.

Head in feet.	Distance from supply to discharge in feet.					
	100	200	300	400	500	600
10	$95	$110	$125	$140	$155	$170
20	38	46	54	62	70	77
30	26	32	39	45	51	58
40	20	25	31	37	42	48
50	19	23	28	33	37	41

The above table and other estimated costs given do not include the value of building or portion of building used for wheel room, which would be about $2 per HP. for head of 30 ft.

To get the cost of a plant of any other size than 1,000 HP. add 1% to cost in table for each 100 HP. decrease, and subtract 1% for each 100 HP. increase. This holds good between the limits of 500 and 2,000 HP.

If the discharge is into the river, the plant will necessarily be greater than that required at average head, and the figures in the table must be increased by the per cent. of reserve power necessary.

The various charges for water in Manchester, Lowell and Lawrence are as follows:

Manchester:
About $300 per year per mill power for original purchases.
$2 per day per mill power for surplus.

Lowell:
About $300 per year per mill power for original purchases.
$2 per day per mill power during "back water."
$4 per day per mill power for surplus under 40%.
$10 per day per mill power for surplus over 40% and under 50%.
$20 per day per mill power for surplus over 50%.
$75 per day per mill power for any excess over limitation.

Lawrence:
About $300 per year per mill power for original purchases.
About $1,200 per year per mill power for new leases at present.
$4 per day per mill power for surplus up to 20%.
$8 per day per mill power for surplus over 20% and under 50%.
$4 per day per mill power for surplus over 50%.

One mill power in Lawrence = 30 cu. ft. of water per second falling through 25 ft. head. The horse power of the water is due to a head of about 1 ft. less than 25, to allow for the loss in getting the water on and off the wheel, so that we have:

$$1\ M.\ P. = \frac{30 \times 24 \times 62.3}{550} = 81.56\ \text{HP.}$$

With wheels of 80% efficiency, the power on wheel shaft equals 65.25 HP.

A mill power in Lowell is equivalent to that in Lawrence.

In Manchester a mill power equals 38 cu. ft. per secon on a fall of 20 ft. Allowing 1 ft. loss we have

$$\frac{38 \times 19 \times 62.3}{550} = 81.78\ \text{HP.}$$

With 80% efficiency on wheels this equals 65.42 HP. on wheel shaft.

The HP. per *M. P.* is near enough to call it the same for these three places, 65 HP. The net effective HP. would be about 60.

Attendance, one man at $2, for 308 days	$616
Oil, waste and supplies	100
Total	$716

or about $0.72 per HP. per year for a 1,000 HP. plant.

STEAM AND WATER POWER COMPARED.

From Tables II. and VI., selecting the conditions from each which suit the case under consideration, can be obtained the relative cost, pure and simple, of steam and water power.

There is no doubt that the great water powers of New England have caused the large manufacturing cities to be established and developed where they have been. At the time of their starting and development the steam engine had not reached such high efficiency as is now obtained. Immense sums of money were expended in some places for the development of the water power and the purchase of rights to use this power. The question is frequently asked, "If steam power is cheaper than water power in many cases, why do you continue to use water power?" The answer to this question is: "Having spent this money, and now having the plant and privilege paid for, it is usually cheaper to use the water power than to put in steam power."

This question could be modified to read: "Could you afford, at the present day, to pay such sums as would be required in the purchase of rights to use, and construction of plant for, water power?" This question can be answered only by careful estimates of cost which have been approximately shown in the tables.

Thus far we have considered simply the cost of power. There may be advantages or necessities attending the use

TABLE VI.—Showing Yearly Expense of Water Power per HP. on Wheel Shaft.

Charges for Water.		Attendance, oil, supplies, etc.	Fixed Charges on Cost of Plant.						Total Yearly Expense per HP.					
Per mill power.	Per HP. per year.		Cost of plant.						For plants costing					
			$50.	$60.	$70.	$80.	$90.	$100.	$50.	$60.	$70.	$80.	$90.	$100.
$300 per year	a	$4.62	$0.72	$5.08	$6 10	$7.11	$8.12	$9.13	$10.15	$10.42	$11.44	$12.45	$13.46	$14.47	$15.49
	b	12.31								18.11	19.13	20.14	21.15	22.16	23.18
2 per day		9 48								15.28	16.30	17.31	18.32	19.33	20.35
4 "		18.96								24.76	25.78	26.79	27.80	28.81	29.83
8 "		37 92								43.72	44.74	45.75	46.76	47.77	48.79
10 "		47.40								53.20	54.22	55.23	56.24	57.25	53.27
20 "		94.80								100.60	101.62	102.63	103.64	104.65	19 .67

EXPLANATION OF TABLE.

a, in column "Per HP. per year," is the cost, not including interest, on the original purchase.

b, in column "Per HP. per year," is the cost including interest on original purchase, which amounts to about $7.49 per HP., or 5% on $10,000 per M.P. per year.

The "Fixed Charges on Cost of Plant" are depreciation averaged at 2½%, repairs at 1½%, interest at 5%, taxes at 1½% on ¾ cost, and insurance at .05% on exposed portion.

of either steam or water which might offset any difference in cost of power simply. Some of the advantages which are favorable to steam power are a steady power through out the year, independent of the rise and fall of a river; more uniform speed than can be obtained from water wheels, which are less sensitive in their regulation than an engine properly regulated; choice in the selection of the site with reference to the markets, low freights, cheap fuel, favorable conditions for building, and procuring and keeping operatives.

Some of the advantages of water power over steam power are the smaller amount of space occupied, which might be available for other purposes, and greater cleanliness. In some cases large amounts of water are required for other purposes than power, and in such cases a location on a stream is desirable.

That the balance of advantages and cost combined is in favor of steam power for textile manufactures is proven at the present time by the erection of steam mills almost entirely, while there are still undeveloped water powers which are available.

In the "Analysis" of Vol. II., Census of Massachusetts, 1885, page cxix., is the following: "It is undoubtedly true that steam is taking the place of water as a motive power, especially in new enterprises. Steam power is also put in for use in case of the failure of the water supply."

A New Device for Tapping and Connecting Branches to Water Pipes.

Under the latest and best systems of laying water pipe it is found economical to provide in advance for future lateral connection with the mains by inserting branches at such points as evident contingencies may require this main to be tapped, and to plug these branches until they are in demand. The removal of this plug is usually a troublesome job and it is very desirable that it should be removed without cutting off the water in the main pipe.

The device here illustrated has this latter object in view. To those not familiar with pipe-laying it should be said that the plug is a hollow casting of a short length and provided with a diaphragm or web cast in it. This plug has a fillet and is inserted in the end of the branch and leaded and calked, like an ordinary pipe, as long as the water is to remain shut off. The general manner of removing this plug is to shut the water off from the main, dig, a trench alongside, break in the web with a hammer, and in so doing flood the trench with water standing in the pipe. This water must be bailed out and the connection is consequently a matter of some hours, as shown in Fig. 1.

In this machine a valve *D* is provided, which is either secured to the exterior of the branch or to the end of the metal plug, if the latter is long enough. In the cut the valve is shown as secured to the branch. The tapping machine, bolted beyond the valve, is made up of a supporting frame *E*, a crank *F*, gear wheels *J*, feed disk *K* and shaft, cutter head and drill. In operation the shaft works through a stuffing box *L*, and the drill first cuts a hole through the centre of the disk *P*. The feed disk *K* is now revolved rapidly until the cutters on the head *H* are brought against the disk *P* and operated until the disk is cut through. A small catch on the end of the center drill retains the piece of metal cut out and this is withdrawn with the drill. It only remains then to run the cutter head with its drills to the outer side of the valve case, screw down the valve and detach the machine.

The machine here shown will tap from 2 ins. to 10 ins. by simply changing the cutter head, and they can be made for sizes up to 48 ins. An improved plug and cap is recommended as shown in Plate II.

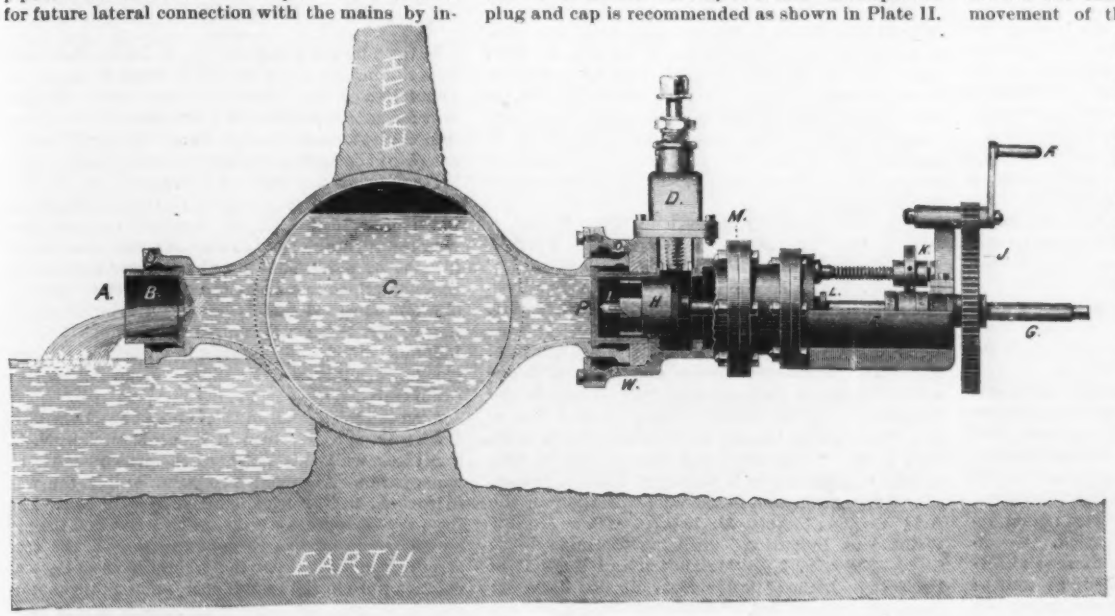


Fig. 1.

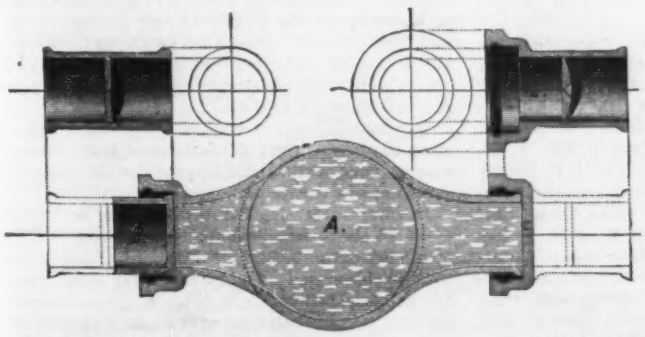


Fig. 4.

Fig. 3.

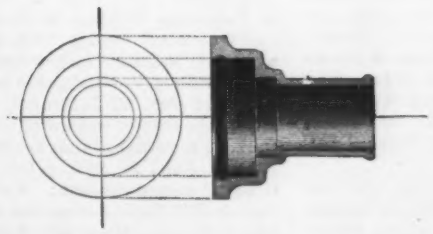


Fig. 5.

Fig. 6.

DEVICE FOR TAPPING AND CONNECTING BRANCHES WITH WATER MAINS.

Fig. 2.

By the use of the branch and plugs there shown, or the short connecting piece, Fig. 4, an ordinary valve can be used in tapping. In cases where no branch has been provided in laying the main, the same tapping device can be used with a sleeve connection bolted on in two pieces, and carrying the laterals. In this case a piece of the required size is cut directly out of the side of the main. For all further particulars inquire of the inventor, Mr. PHILIP ELEY, 32 East Twenty-fifth St., Bayonne, N. J.

Evolution of the Elevator in America.

In the December issue of the *Journal of the Association of Engineering Societies*, Mr. R. M. SHERIDAN, of Kansas City, gives an interesting sketch of the evolution of American elevators. Mr. SHERIDAN says that the year 1855 witnessed the first practical effort to utilize steam in lifting goods by means of a platform moving vertically, thus supplanting the old single sheave arrangement and hand winch.

This first effort was complicated and clumsy and no material permanent improvement was made for ten years or more.

In this as in many other devices, the parent Necessity begot the child Invention. The rapid material growth of American cities following the Civil War called for higher and higher buildings, and the "elevator" came as a consequence. The distinctive use of this device for carrying passengers only is of unknown date, although the writer says that the first regular steam passenger elevator was produced in 1870. This machine was driven by a double reversing engine with oscillating cylinders.

A pulley and belt conveyed power to an axle which carried a pinion intermeshing with a moulded spur-gear upon the periphery of a drum; over this drum, in turned grooves, the cables were wound which hoisted the car. Owing to the spur gearing the movement of the car was pulsatory or "jerky."

Later efforts tended toward the smoother running of the car, and now the same engine is used, but the cylinders are stationary, the belt is dispensed with and the power is communicated to the drum by a phosphor bronze gear wheel with teeth cut to the epicycloidal curve, and a cut steel worm fixed upon the crank shaft. The drum is made of large diameter so as to admit of considerable speed upon the car without increase of piston speed beyond economical limits.

At various times during the last 20 years experiments have been made in the direction of using hydraulic power; but it is only in the last 10 years that success has justified the introduction of this class of elevators. As the writer says, the working of these hydraulic elevators can only be properly explained by means of diagrams and illustrations. It is sufficient to say that continued experiments and mechanical skill have combined to make them rapid in motion and exceedingly safe in operation. With carefully designed and properly constructed machines, accidents are very rare; and the proportion of accidents to the number of elevators is insignificantly small.

In the great cities structures rise in many instances to 15 and 16 stories in height, and speed, therefore, has become the great desideratum. As an example of what is done in this direction, the service to the offices in the tower of the Chicago Auditorium is cited. Here the elevators travel through a height of 220 ft. at the rate of 600 ft. per minute, or about 7 miles per hour. The requirement for ordinary buildings is a speed of from 300 to 450 ft. per minute.

We may state for ourselves that the elevators in the Auditorium referred to above start without any jerks, and ascend and descend so smoothly that there is no sense of too rapid motion. The designers of elevators are certainly well able to meet the demands of the most ambitious architects; and that the end is not yet is evident from the article in our last issue, describing three elevators, side by side, and now under construction, each capable of lifting 130 persons 145 ft. high per trip.

Publications Concerning Irrigation in the United States.

The information concerning irrigation in the United States is mostly scattered through various reports and periodicals. There are so many calls for books on this subject that we have prepared the following list, which is as complete as we can make it at the present time. We should be pleased to receive the names of any important books or reports omitted from the list, and avail ourselves of this opportunity to request from all irrigation engineers copies of reports made by them, for review, and photographs, drawings or blue prints of irrigation works in operation, under construction or proposed.

Perhaps the most important contributions to this class of literature are the volumes published by the State of California, and prepared by WILLIAM H. HALL, formerly State Engineer. These volumes are for sale by the State at $3 each, including postage, and may be obtained by addressing W. C. HENDRICKS, Secretary of State, Sacramento, Cal. The work as originally projected was to be in four volumes. Two of these were published some time ago, and are now available; the third is about to be printed. The first volume is entitled "Irrigation Development," and contains a review of the growth of irrigation works, customs and laws in France, Italy and Spain. The second volume is entitled "Irrigation in Southern California," and is devoted to existing works and practices in San Diego, San Bernardino and Los Angeles counties. The third volume will be devoted to central California, to the Kern, Tulare and San Joaquin valleys. The fourth volume, in contemplation, would treat of the Sacramento and other valleys in northern California.

The reports of the State Engineer of Colorado, issued every two years, are of great value, inasmuch as they show the nature, extent and growth of irrigation in the State, and discuss the working of existing laws. The first report was for the two years 1883-4, and the report for the past two years has just been presented to the Governor.

The reports of the engineers of other States and of the territories of the arid regions contain more or less information on this subject, as do the reports of some of the territorial governors.

Of U. S. Government reports the most important one issued thus far was submitted to the Department of Agriculture in 1886 by Col. RICHARD J. HINTON, entitled "Irrigation in the United States." This report contains a general discussion of the subject, brief descriptions of several irrigation works, and many letters from all over the arid region regarding the effects and value of irrigation. A summary of the irrigation laws of the States and territories in the arid regions is presented, as well as data regarding the same in foreign countries. An appendix presents extended abstracts from an Australian report on American irrigation and another appendix gives information regarding irrigation in Mexico.

Another government report published in 1882, treats of artesian wells upon the great plains, and was made by C. A. WHITE and SAMUEL AUGHEY. Another, also published in 1882, treats of the climate, agricultural features, practices and needs of the arid region of the Pacific slope, and contains notes on Arizona and New Mexico. This report was made by E. W. HILGARD, T. C. JONES and R. W. FURNAS.

In this connection it should be stated that the government has in preparation additional reports upon irrigation, including the report of the recent Senate Irrigation Committee and a report by the Department of Agriculture.

Reports that may be mentioned by name only, are: "Report on the Irrigating and Reclaiming of Certain Desert Lands in Idaho," by A. D. FOOTE, C. E., of Boise City, Ida; "Reclamation of Arid Lands by Irrigation," a report of the irrigation committee of the California State Board of Trade, 605 Market St., San Francisco; "Reports on the Projected Works of the Tulare Irrigation District," Tulare, Cal.

A most commendable review of the whole subject of irrigation appeared in the San Francisco *Chronicle* of Aug. 23, 1889. The long article therein presented was entitled "How to Make the Desert Blossom as the Rose."

An important report bearing upon this subject is one published in 1888. It consists of a "letter" sent by the Chief Signal officer to the Secretary of War on "Rainfall of the Pacific Slope and the Western States and Territories." This report contains valuable tables, maps and charts illustrating its subject.

Some of the above reports can doubtless be obtained, free of charge, on application to government or State officials, but the writer believes that most of the government reports are out of print, and can be obtained, if at all, only at second-hand book stores.

The publications thus far mentioned appeared in book form, all in paper covers, excepting the volumes written by Mr. HALL.

Of course those interested will look up the articles on the general subject of irrigation in the various Encyclopedias, notably in the *Britannica*, where Prof. A. H. CHURCH has 10 pages on irrigation, and Appleton's *Annual Cyclopedia* for 1889, where 13 pages are given to a review of "Irrigation in the United States." We subjoin by title articles that have appeared in technical papers or have been read before engineering societies and printed in their official organs. Doubtless some such articles or papers are omitted, owing to the fact that no general index of the publications in which they appear is available.

The following references are to the more important matter on this subject which has appeared in ENGINEERING NEWS:

"Irrigation in Northern Colorado," by Prof. E. MEAD; May 3, 1884, p. 211. "Irrigation Engineering in the West—An Irrigating Canal," by C. A. MILLER; June 28, 1884, p. 325. "Irrigation in Colorado," review of State Engineer's report; March 28, 1885, p. 200. "Irrigation ditches in the United States," relating to matter on this subject in the Tenth U. S. Census; Jan. 2, 1886. "Irrigation Engineering in the Former Home of the Aztecs," by M. J. MACK; Dec. 31, 1887, p. 468.

"The Merced (Cal.) Irrigation Canal;" Feb. 4, 1888, p. 83. "Irrigation in the West;" April 28, 1888, p. 338. "The Laying Out of Irrigating Canals;" by H. P. BELL; May 5, 1888, p. 359. "A New Irrigating Project in Idaho;" June 23, 1888, p. 510. "Irrigation and the Great West;" editorial; June 30, 1888. "Irrigation in the West;" Aug. 4, 1888, p. 92. "The Mississippi River and Storage Reservoirs;" Sept. 8, 1888, p. 184. "Irrigation in the Arid Regions of the United States;" Nov. 3, 1888, p. 351. "Irrigating Canals in Montana;" March 30, 1889, p. 285. "Irrigation and Rain;" May 11, 1889, p. 425. "Irrigation in Wyoming;" June 8, 1889, p. 525. "Irrigation and National Legislation in the Arid Region;" Aug. 31, 1889, p. 209. "A New Wrinkle in Irrigation" (utilizing the underflow); Sept. 7, 1889, p. 226. "Irrigation and Rock Dam Projects in Idaho;" letter from FRANK RIBLETT; Sept. 28, 1889, p. 307. "Notes on Irrigation," abstracted from articles in the Salt Lake *Tribune*, by C. L. STEVENSON of that city; also "Irrigation in Utah Co., Utah;" a note; Oct. 5, 1889, pp. 320, 321. "Irrigation in Cassia Co., Idaho;" a note; Oct. 12, 1889, p. 354. "Constitutional Provisions Relating to Irrigation in Wyoming and Montana;" Nov. 2, 1889, p. 417. "Head Gates and Boom of Main Canal, Dolores, Col." (with inset); Jan. 4, 1890, p. 7. "Irrigation in Idaho," (data from report of Gov. G. L. SHOUP); Jan. 4, 1890, p. 18. Also, same subject (review of report by A. D. FOOTE, C. E., on reclaiming lands between Snake and Boisé Rivers); April 26, 1890, p. 391. "The 'New Era' Grader," correspondence; March 15, 1890, p. 255. 'Rock Fill Dam Across the Pecos River," illustrated; May 17, 1890, p. 459. "The Jurapa (Cal.) Irrigation Canal," illustrated; May 17, 1890, p. 463. "An Automatic Waste Gate," illustrated; June 21, 1890, p. 578. "Irrigation in Wyoming," abstracted from report (1888-9) of ELWOOD MEAD, Territorial Engineer; Aug. 2, 1890, p. 93. "The Relation of Irrigation Problems to Forest Conditions," abstracted from a report of B. E. FERNOW, Chief of Forestry Division of the U. S. Department of Agriculture; Sept. 6, 1890, p. 203. "The Wright Irrigation District Law;" Jan. 10, 1891, p. 37. "State Irrigation Commended;" Jan. 10, 1891, p. 43.

"Irrigation in Northeastern Colorado," by O'MEARA; appeared in *The Engineer*, April 27, 1883. "Irrigation in California," by DOW, appeared in the *Scientific American Supplement*, Jan. 5, 1884, and "Irrigation Canals of Northern Colorado in the same journal, Sept. 11, 1886, as did "Irrigation Machinery on the Pacific Coast," by JOHN RICHARDS, Dec. 1 and Dec. 24, 1887. The latter appeared first in *Engineering*, Nov. 4, 18 and 25, 1887. "Irrigation in Colorado, as seen by the American Society of Civil Engineers," illustrated; *Sanitary Engineer*, Aug. 5, 1886. "Irrigation in the United States," a review of enterprises carried out in the last few years; *Engineering and Mining Journal*, Jan. 5, 1889. "Irrigation Engineering," a paper reviewing the general problems to be considered, by H. M. WILSON, in Columbia *School of Mines Quarterly*, Jan., 1890. "Large Irrigation Canals,' condensed from a paper by G. G. ANDERSON, C. E., read before the Denver Society of Civil Engineers; *Railroad and Engineering Journal*, July, 1890, p. 307. "The Function of the Government in a Plan for General Irrigation," by GEORGE A. BROWN; *Journal of the Association of Engineering Societies*, October, 1890.

The following articles have been published in the *Transactions of the American Society of Civil Engineers:* "Irrigation," by EDWARD B. DORSEY, C. E.; vol. xvi., pp. 85 to 102, and discussion, pp. 102 to 133; this paper and the discussions contain much of the most valuable matter to be found on the subject" "Water Meter for Irrigation," by ARTHUR D. FOOTE, C. E.; vol. xvi., p. 134. "Automatic Waste Weir," ARTHUR D. FOOTE, C. E.; vol. xviii., p. 59.

Locomotive Sheds and Locomotive Fire Extinguishers.

In the admirable paper of Mr. J. DAVIS BARNETT, Superintendent of the Stratford shops of the Grand Trunk Ry., on the "Design and Construction of Railway Shops" (ENGINEERING NEWS, Oct. 19, 1889, *et seq.* reference was made to the almost universal American plan of designing locomotive roundhouses so that all the tracks converge at a turntable pit outside. Mr. BARNETT called attention to the serious defect in this plan, in that all the locomotives must pass over the turntable, and in case of accident to this, or in case of derailment on the narrow exit tracks beyond, all egress from the roundhouse may be blocked. Instead of this American type of engine house, Mr. BARNETT favored the English plan of building engine sheds with longitudinal through tracks, so that in case of accident to one exit another can be used.

A recent occurrence in the yards of the Delaware, Lackawanna & Western R. R. at Montclair, N. J., illustrates well this defect of the prevalent American system. At about 1:30 A. M. Jan. 20, fire was discovered in the freight house at Montclair. The local fire companies were slow to arrive and the fire spread so rapidly as to endanger some of the cars standing on tracks near the freight house. Several engines were in the roundhouse, and one was immediately started out to move the cars to a safe position; but in the hurry and confusion it went off the track at the turntable, which, of course, blocked all the other engines from passing out. Some barrels of kerosene on the freight house platform burst, and their burning contents ran down the tracks, setting fire to six passenger coaches and six box cars, which were totally destroyed. The total loss by the fire will approach $100,000.

The radial type of engine house has certainly some advantages; but if it is thought best to use it, an emergency exit should be provided in case of accident at the turntable.

Another interesting lesson which may be learned from the above described accident is the value of the steam fire extinguisher attachment to locomotives. This has been used on a few roads for some years, but has been rather slow to come into general use. It consists merely of an ejector or steam jet pump taking steam from the boiler and water from a hydrant, or from the tank, as may be convenient. It is an inexpensive attachment, with no moving parts to get out of order or require attention, and it can throw a stream of very considerable size and force. Fire in a roundhouse is not at all uncommon, nor is it uncommon for a number of locomotives to be destroyed by the flames. As a safeguard against this danger alone, at least one locomotive in every yard ought to be equipped with fire extinguishing apparatus. Its service in case of fire about yards or stations, as well as for ordinary use in washing and filling boilers, washing platforms and cars and similar work, make it an appliance worth much more attention from railway men than it has received.

Subaqueous Foundations.*

(*Concluded from page 67.*)

BREAKWATER AT JERSEY.

As chief and consulting engineer for the Hermitage Breakwater and other works at St. Helier, Jersey, I had to consider very carefully what design should be adopted to meet the requirements of the locality. In a report, dated May 9, 1877, to the committee appointed to inquire into the actual state of the new harbor works at Jersey, Sir JOHN COODE stated: "That during the gale of Dec. 3, 1876, railway metals standing less than 6 ins. above the surface of the Hermitage Breakwater, and firmly spiked down to the masonry, were twisted and thrown out of line to such an extent as to stop the traffic. I know of no port where the elements to be contended with as to force of sea, rise of tide, and irregularities and difficulties of foundations were of so formidable a character as at St. Helier's." This was the picture drawn by Sir JOHN, when the works were stopped in 1877, of the locality in which I was about to continue the Hermitage Breakwater in 1887, for 525 ft. seawards. The end of the work, in 1877, was on rock a little beyond low water mark. The breakwater is exposed to the Atlantic, and subject to heavy southerly and southwesterly gales, and, therefore, during the progress, should always have a reliable scar end, if possible, equal in strength to the finished end of the breakwater.

The depth of water in which the works have been founded at high water of spring tides is 60 ft.; the range of a high spring tide being about 40 ft. Over about two-thirds of the length of the foundations the rock was exposed at the bottom of the sea, and over the remaining portion there was an overlying deposit of sand and clay, varying in thickness from a few inches to about 8½ ft. The rock on which the work is founded is granite, the surface of which is very irregular. The system of construction I adopted was to make the work as nearly a monolith as possible throughout, from the very irregular surface of the foundation on the solid rock up to cope, and instead of founding on such materials as sand and clay along the portion of the site where these occurred, I had them entirely removed down to the solid rock, so that the whole of the work should be founded on it. The leveling up of the irregularities in the rock, in order to form a perfectly level bed or base upon which to found the blocks, was a work which required great care in execution, but ultimately it was very simply and expeditiously effected by the system of grouting to which I have already referred, and which has been further and most successfully used in grouting up the beds and joints of the blocks, and making solid work from about low water level of neap tides down to the leveled surface of the foundation on which the first course of blocks was founded, or for a height of nearly 30 ft. Various expedients were tried, shortly after the commencement of the work, as to the simplest and most efficacious methods to be pursued in the construction of the subaqueous portion of the breakwater, but that which I will now describe proved to be the most useful in practice, and ultimately became the ordinary routine pursued during the execution of these works. The sand, clay, gravel, etc., overlying the rock were dredged by means of a digger grab, worked by a steam crane mounted on a barge. The foundation trench dredged was about 50 ft. in width at the bottom, and the portions of the soft materials in the irregularities and crevices of the rock, which could not be dredged by the grab, were removed by divers, so as to insure a perfectly reliable foundation on the surface of the cleaned rock throughout the entire length of the breakwater. When the rock was thoroughly cleared, the trench was filled in with rubble and shingle, which were thrown overboard, sometimes when there was a moderately rough sea on, and when it would have been quite impossible to have properly deposited ordinary concrete from a barge into the trench. The top surface of the filling of the trench was leveled off at a fixed height. The leveling was done by divers by means of stiff timber straight edges, with spirit levels let into their upper surfaces, and smaller and similar straight edges were used for transverse leveling between the larger straight edges. The work was advanced in lengths or sections of 12 ft. 6 ins., so that three courses of the sloping layers of blocks were brought up at once. The reason for such advance being that this length, together with that of the slope of the blocks, suited the outreach of the block setting crane. The excavation in the foundations, and filling in of the trenches with rubble and shingle, were likewise carried out in similar lengths. When the rubble and shingle bed had been brought to the proper height and leveled off, it was then grouted into a solid mass with neat Portland cement grout; but in order to prevent the escape and consequent loss of cement from the filling up of each 12 ft. 6 ins. length or section, it was inclosed by bags of concrete on three of its sides, and made cement-tight all round. This was effected in the portion of the work where excavation had to be done by simply placing across the end of the section a wall composed of bags of concrete of about 7 ft. 6 ins. by 4 ft. by 2 ft., piled one on the other and leveled to the same height as the rubble and shingle, and, further, by stopping up whatever crevices or spaces might exist between the large bags by small bags, or by canvas, according to the size of the crevices. The sides of the excavation prevented the escape of cement at these places, so that bags were not required; but along the portions of the site where there was neither sand nor clay overlying the rock, the bags had to be placed along the two sides of the work as well as across the end, in order to inclose an area for the foundation bed, and to prevent the escape of the cement. At such places the leveled grouted rubble and shingle stood above the bed of the sea, instead of in a trench below it.

When the rubble and shingle of a section had been placed in position and leveled off, and all the crevices in the end and side walls formed of bags of concrete, the filling was grouted up with a thick cement grout, which was passed down through a 3-in. stand pipe, the funnel mouth of which was placed above high water level, and the lower and perforated end inserted by divers well down into the mass of loose rubble and shingle. The cement was worked into a thick grout on a platform or box, suspended from the jib of the block setting crane immediately over the site, or nearly so, of the area to be grouted. This platform was of sufficient size to hold from 20 to 40 bags of cement, and to enable a gang of from

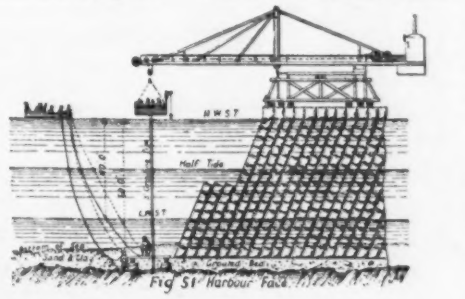


Fig 51

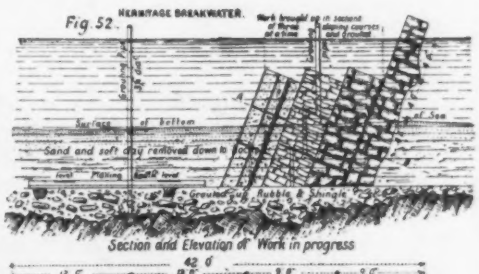


Fig. 52. Section and Elevation of Work in progress

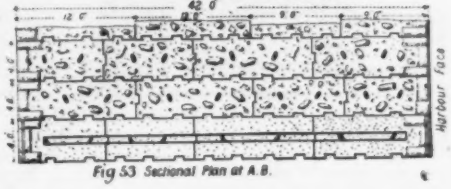


Fig 53 Sectional Plan at A.B.

6 to 8 men to work on it. It was always hung at a fixed height of a few feet above high water mark, so that the pipe was of a fixed length and thus avoided the adding to or shortening of the pipe, according to the rise or fall of the tide, as would have been necessary had the grouting been done from a barge. In preparing the grout and passing it through water very great care was required, and the workmen had to be trained before they could be intrusted to do the work properly without supervision. Cement grout may be so prepared or so passed through water into the work as to be utterly useless. I am assuming that the cement is fit for the purpose. To be reliable it should be very finely ground, the test for fineness being at least 90 per cent. to pass through a sieve of 6,400 meshes to the square inch.

Cement of a greater fineness, from 8,000 to 10,000 meshes to the square inch, has been used experimentally in the work, and it was found that the finer the cement the better the grout for making solid work. It should be manufactured from picked, well burned clinker, and as free as possible from extraneous matter, such as magnesia, excess of lime, etc., and used as new as possible. If the cement be not finely ground, the coarser particles will deposit much more rapidly than the finer in the lower end of the stand pipe, where they will remain and give trouble; but as far as the setting or cementing properties of the coarser particles are concerned, they are practically as inert or useless as sand. If the cement be fresh it will set, after being deposited in the form of grout in the foundation, in a couple of days or so, sufficiently hard for the foundation course of blocks to be laid on the newly formed foundations; sometimes it takes very much longer to set, and the rate of progress of the main work is, therefore, much hindered. In mixing the cement to form grout, the practice of preparing it by placing in a mixing tub a quantity of water and adding and stirring in cement until a certain degree of consistency is obtained, must be carefully avoided, as this process effects a mechanical separation of the particles, whereby the cement is rendered almost useless for the purpose intended, and if in this condition it is simply poured down on to the top of the shingle and rubble to be cemented together, it is still further washed or dissipated.

I believe that experimental grouting has been done in this manner by some engineers, and other engineers have added sand to the cement grout, but failures only could be expected as the results of such departures. The proper course to be pursued is to mix the cement on a flat surface or platform to the consistency of stiff paste, place it in a tub, and then slightly thin it down by adding water in very small quantities, and stirring until the paste is reduced to a thick grout, or just soft enough to leave the bucket from which it is to be poured as rapidly as possible into the hopper or funnel attached to the head of the pipe. The finer the cement and the quicker it is poured down the pipe to keep up a continuous flow or column, the better will be the results obtained. The only drawback to thick grout is that sometimes the pipe gets choked at its bottom end, that is, if sufficient attention is not given by the men; but even this can be avoided to a considerable extent by simply pouring some water down the pipe as soon as there is any appearance of an obstruction. The lower end of the pipe, which is open and also perforated with ¾-in. holes for 12 ins. up, is placed by divers well down into the mass of loose materials, and the grout is forced into the interstices of the rubble and shingle filling by the weight or column of grout in the pipe, which is equal to about half the depth or head of water in which the grouting is being done.

It has been observed that generally half a column of cement balances a full head of water—that is, a column of 30 ft. of cement grout is balanced by about 60 ft. head of water. Any greater height in the cement column represents the amount of pressure necessary to force the cement upward through the interstices to the surface of the filling. As the grout descends in the pipe it rises in the rubble filling, and so the water is displaced or driven out. This displacement may extend to a distance of 15 ft. from the pipe, as ascertained by work done. It is much better, however, that the distance traveled by the cement from the lower end of the stand pipe should be as short as possible, and in the bed of the Hermitage Breakwater it was not allowed to travel more than 5 or 6 ft. When the diver saw that the grout from the stand pipe had forced its way up through the mass of materials to the surface, he then had the pipe shifted to another position, by which a similar area was grouted, and so on, until the entire mass was filled up. The grouting is first carried on all round by placing the stand pipes close to the sides and ends of the section of foundation in progress, and the central area is afterward completed. One diver was generally sufficient to attend to the pipe in having it shifted from place to place as required, and likewise to stopping up the crevices in the inclosing walls of bags of concrete, whenever he observed cement escaping. When the grouting had partially set any irregularities on the top surface which might have been caused by the grout rising in some places considerably above the general level of the surface, and especially at the places where the stand pipe had been inserted, were removed by the divers, who used straight edges, faced with iron, which were passed over the excess of grouting, and thus planed off or dressed them down to a true and perfectly level bed. The whole surface was then allowed to set into a solid and compact mass of concrete, free from all crevices or openings, which in other methods of founding are chiefly the direct cause of most of the foundation failures in connection with sea works, especially where dry blocks have been founded on an unreliable bed and surmounted by a heavy superstructure. The time occupied by the divers in preparing and grouting up a bed of the full width of the foundation, and for a 12 ft. 6 in. section, or length of breakwater, was from a week to 10 days, and the cement used in grouting up the loose materials to form a solid mass was about one-ninth of the weight of the rubble and shingle cemented together, but with larger blocks of rubble stone with shingle between them it would have been less.

When the grouting of the bed had become firmly set, block-laying on top thereof was proceeded with, the first, or foundation course being composed of blocks, two sides of which were sloped, corresponding with an angle of inclination of 68° with the bottom. All the blocks above the foundation course were 4 ft. square in section and in 9 ft. and 12 ft. lengths, being equal to about 9 and 12 tons respectively. The foundation course of blocks and 3 or four courses on top of the same, were laid by divers; the level of the upper surfaces, or bed joints, of the topmost of these blocks is about half way between low water level of spring and neap tides. All the blocks above this level up to coping were set in position by ordinary masons, at such times of tide as enabled work to be done, and laid dry, one on top of the other, for two courses in height, and after the outer vertical and horizontal joints had been stopped with quick setting cement, or caulked with canvas, the open beds and joints between the blocks in the two courses were filled up with thick neat Portland cement grout; two more courses were then added and grouted up in a similar manner, and so on up to coping level. For caulking up joints below low water a different

* By Walter Robert Kinipple, M. Inst. C. E., reprinted from *Engineering*.

arrangement was required, consisting partly of Portland cement, inclosed in calico cases or stockings, and partly of jute sacking rammed or caulked into the joints of the blocks. In caulking the joints below low water by divers, proper arrangements had to be made to insure its being carried on expeditiously and economically. Grooves were first cut in the joint faces of the granite ashlar at a few inches in from their exposed faces, after the blocks had been moulded and allowed to set and be well seasoned. The form of the groove in each block is semicircular, so that when the blocks are laid in position complete circular grooves are made in the joints. The diameter of these grooves is about 3 ins. The calico casings or stockings are, when completely filled with Portland cement, a trifle larger in diameter than the grooves formed in the upper and lower joint meeting faces, and as the blocks are lowered on to their beds, so the stockings become tightly squeezed into the half grooves, and the joints are rendered cement-tight. For the purpose of caulking the vertical, or rather sloping outside face joints, a tin tube is used of about 5 ft. in length, and of somewhat smaller diameter than the grooves. The tube is filled with slightly damped neat cement, and inserted into another loose stocking, and, with the stocking on it, is lowered down to the diver, who inserts it into the joint groove. A plunger is then rammed into the tube, and the cement is forced out into the stocking, and in escaping forms a most effectual, well filled, hard, cement-tight joint. The vertical and horizontal joints across the scar end of the breakwater are, as the work progresses, caulked with canvas, which, for temporary joints, is found to be very useful, more especially as the canvas can be pulled out of the joints as each section of the breakwater is built up, and so enables the open joints left by the removal of the canvas to be grouted up. When the caulking is complete, the beds and joints between the blocks are then filled up solid with thick neat cement grout, in a manner similar to that which I have already described for the foundations, the stand pipe through which the cement is passed being placed successively in the lewis holes formed in the various blocks for the insertion of the lifting rods. Not only is the work rendered monolithic from foundation to cope by cementing the whole mass together, but in order to increase the security of the work, an arrangement of grooves and projections on all the surfaces of the blocks, save the outer or granite faces, has been adopted, whereby each block fits into, or is, so to speak, keyed on to the adjoining blocks.

In the 42 ft. width of the breakwater, there are four blocks, viz., two each of 12 ft. in length, and two of 9 ft., weighing respectively 12 and 9 tons. In each layer or course, break-bond at the joints is neither resorted to nor required, the omission of which effects a very great saving in the cost of diving time, and very greatly facilitates the execution of the work. The blocks are laid, or piled, one on top of the other, and any irregularity in the setting of a foundation block is simply repeated, block after block, until the finishing work built *in situ* at coping level is reached, where all irregularities are easily worked out. This can be done in the top of each pile of blocks without the slightest detriment to the work, for between each sloping layer, or course of blocks, there is a minimum cover or break-bond, of at least 3 ft. at its joint, with the last layer. This arrangement of stacks, or piles of long and short blocks, with a break-bond of 3 ft., makes most excellent work. The maximum weight of 12 tons for the blocks was adopted to suit the appliances on the works. The blocks were built of granite rubble masonry, set in Portland mortar, composed of four parts of clean coarse sand and one of cement; the outside or facing blocks were faced with granite ashlar set in two to one Portland cement compo. The blocks were hard enough to be lifted in the summer season at three days after being built, and in the winter season from five to seven days, according to the state of the weather. After being lifted out of the block-building pit they were allowed to harden well in the stacking yards before being placed in position in the breakwater.

This system of constructing a breakwater presents considerable advantages, as regards economy, expedition, and reliability. The Hermitage Breakwater was executed, when everything was going at full speed, at the rate of about 300 ft. per annum. Its width is 42 ft., and total height from foundation to coping 65¼ ft. During progress there was not the slightest mishap of any kind after the blocks were grouted up, although very heavy seas had sometimes to be resisted almost immediately after the blocks were set and grouted up. The cost of the 525 ft. extension of the Hermitage Breakwater has averaged about £100 per linear foot run complete. Seas, indeed, have been experienced at this breakwater such as no ordinary dry block work system could have successfully withstood for many years, for had even one of the blocks been removed, others would have soon followed, and to repair such damage by underpinning with bags, or dry blocks, in such an exposed locality, would have been almost a physical impossibility, or at all events could not have been permanently and well done. The experience in connection with the failure of the dry block system at the south breakwater at Aberdeen in the year 1883 is well known, and at Wick some years before this time, when almost the entire breakwater failed, and became a mass of ruins.

Had time permitted, I could have made reference in detail to other examples of works executed, which go to show the gradual development in the system of construction of sea piers, from the rubble mound up to the solid vertical, or nearly vertical, wall. However, I think I have given sufficient examples to indicate the tendency of engineers at the present time toward vertical walls as largely monolithic as possible, and founded either on the natural sea bottom, or if on the top of a rubble mound, at a considerable depth below low water. My own opinion, which I have endeavored to express as clearly as possible, is, that breakwaters should be entirely monolithic from foundation to coping, and that the foundations, except in cases of extreme depths, should be carried down to the natural sea bed if rock, or if soft material, to a sufficient depth below such bed as the circumstances of the case may demand, besides taking further necessary precautions to guard against scour along their bases. The system of grouting which I have introduced and used so successfully at many sea works, large and small, when taken in conjunction with concrete blocks or granite-faced blocks, as in the works executed by me at Girvan and Jersey, shows what can be done with small blocks in securing solid work with a durable face, and with a very moderate amount of plant. Frequently the item of plant is most important, and bears a large proportion to the entire cost of the work. Especially is this the case in sea piers for small fishing harbors in exposed positions, where funds are comparatively limited, and the cost of plant and temporary works must be kept at a minimum. The system of grouting with small or moderate sized blocks meets cases of this description exactly, but is also equally suitable for the construction of breakwaters in a site, such as that at Alderney, where the depth reaches to as much as 71 ft. at low water or 88 ft. at high water. In such a case as this a rubble mound could first be deposited, having its top leveled off at from 25 ft. to 30 ft. below low water, and on the top of this a superstructure formed of blocks weighing 10 to 15 tons each, and grouted together with neat Portland cement. The weight of blocks to be adopted in any particular case is, of course, dependent on the amount of work to be done, sum to be expended, time for execution, and various local conditions.

As the inventor of the grouting system, I may be inclined to attribute more importance to this method of obtaining sound and substantial subaqueous work than in reality is due to it, but knowing from experience the excellent work which I have done by this means, without accident or loss of cement, sometimes under the severest conditions, and always at a low cost, I do not think that I can speak too highly in its favor, or that I can make it too widely known, for I feel sure that it only requires to be known and thoroughly tried to be adopted in the majority of cases in lieu of the dry block system.

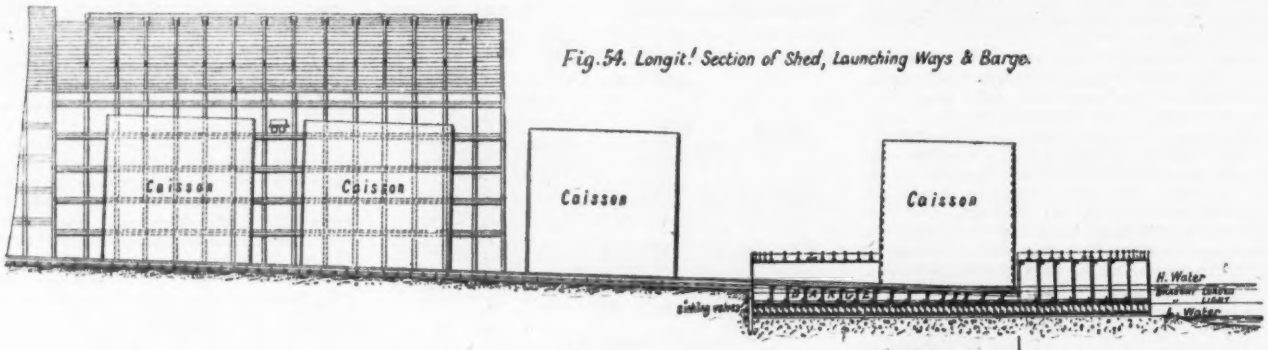


Fig. 54. Longit.l Section of Shed, Launching Ways & Barge.

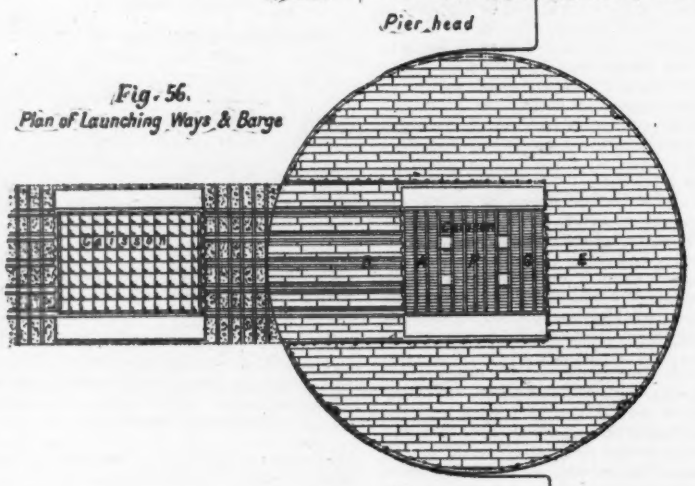


Fig. 56.
Plan of Launching Ways & Barge

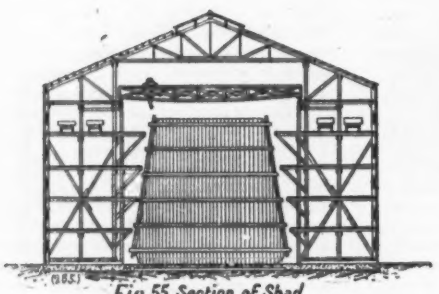


Fig. 55. Section of Shed
Showing Mould for making Caissons.

"Lifts" in England and on the Continent.

The following is from a late issue of the N. Y *Tribune*:

London may not be provied with elevators on anything like the scale that New York is, said a man, recently, who spent his vacation abroad, but I saw a "lift" there, the like of which I do not believe exists in this country. I entered an office building in London, which was not far from the Bank of England, to see a friend, who was on the top floor. In the corridor I saw a number of boxes following one another up one shaft and down another. They were attached to an endless chain, and were large enough to hold several persons. I looked at the machine in some doubt, when suddenly a man stepped out of one of the boxes or cars, which was coming down. The car, which was going at what seemed to me a rather rapid rate of speed, did not stop, the man jumping off it while it was in motion. Pretty soon I saw other men jumping in and out of the cars, which were about as far apart on the endless chain as the distance from floor to floor. I at first hesitated about risking my limbs and life on the contrivance, but finally stepped into an ascending car, just before its bottom was on a level with the floor. No sooner had I done this than I began to fear that I might be crushed to death between the car and the floor or ceiling when I tried to step off. Of a sudden it struck me that if I did not get off at the top floor I would be carried to the roof and then be stood on my head in the car as it turned over. I was in a perfect fever of anxiety, and could hardly screw up my courage to the point of alighting, but I managed to do this when the top floor was reached. I found that it was much easier to get out than I had supposed, and when I finished my call I boldly rode down on the machine. I afterwards learned that a man who did not get out of an ascending car at the top floor would be in no danger of being turned upside down at the top of the shaft, because the car always maintains its upright position. This is due to the fact that only the roof of the car is fastened to the cable, so that the car always remains bottom downward by its own weight. A "lift" like this may be economical, as it does away with the need of men to run it, but I myself much prefer the safe American machine.

The lift described by the *Tribune* correspondent is in the Mansion House Chambers, Queen Victoria St., but the boxes are solid, and by an arrangement on the back they change the vertical to a horizontal motion at the top and bottom of their path. Passengers do slip at times, and "precautions" are taken looking toward this incident. An American engineer, well known for his connection with elevator machinery, once told us that he came across this same London lift, and besides investigating the device at the top, he went into the cellar to find the motor. The driving device was an old-fashioned belt machine, and the American noticed that the belt was very slack. After some introductory chat, he ventured to point out this feature to the "engine-driver" in attendance, and the reply somewhat startled him. "Yes, sir, I know it is; but we keeps it so a purpose, to catch any man what slips." In other words, instead of being mashed between the floor of the cage and the ceiling above him, the awkward traveler, by a merciful device, simply stopped the whole chain of boxes.

This reminds us of other lifts seen in Paris hotels; where a stout young man turned a heavy fly-wheel inside the cage; and by much muscular effort and a sort of rack-and-pinion device, slowly wound the car up to the top floors. The upward motion was so slow, and the slips, halts and jerks so frequent, that had it not been for the name of the thing, it would have been much more comfortable to walk up-stairs. A Swiss hotel also conspicuously advertised the fact that it had "a lift" provided with "the most satisfactory safety appliances." On inspection this appliance was found to be a chain cable of dimensions sufficient to anchor a small-sized man-of-war. There is evidently a field abroad for the elevators of American type; and a fast-going "hydraulic," so common in our loftier office buildings, would probably astonish our European cousins quite as much as some of their devices astonish us.

A Library Indicator for Books.

A library indicator system is in use in the Edinburgh public library, founded by Mr. ANDREW CARNEGIE, of Pittsburg, Pa., that is worthy of note for its simplicity. The purpose is to indicate whether a certain book is in the library or out of it. The ten "indicators" are each about 6 ft. square and occupy places on a horseshoe shaped desk. Each one contains 4,000 numbers, running consecutively up to 40,000, and each number has a small drawer just large enough to hold a card. One end of the drawer is red and the other end blue. If the red end is out the book corresponding with that number is not in the library and the card of the person who has it is in the drawer. When the book is returned the blue end is turned out and the card restored to its owner. The system saves time, labor and expense, and is a scheme that might be usefully applied in some industrial establishments as well as in libraries, for indicating the whereabouts of workmen, etc. We obtain the above description from an interesting report on Public Libraries in Great Britain, made by U. S. Consul BRUCE, of Leith, and published in Reports of Consuls of the United States, No. 121, October, 1890.

The Qualities Essential for a Free Steaming Locomotive.

The paper with the above title, read before the New York Railroad Club on Jan. 15, was briefly abstracted in our last issue. We give some further extracts from the paper, as follows:

The number of square feet of boiler heating surface for bituminous coal burning engines should never be less than four times the square of the diameter in inches of a cylinder one inch larger than the cylinder to be used. One-tenth of this heating surface should be in the firebox and the balance in the flues. On anthracite burning locomotives more heating surface is needed in the firebox on account of the larger grate area required, but the heating surface of the flues, as given by the above rule, should not be materially decreased.

The grates should be designed to admit the greatest amount of air possible. The amount of air admitted can be regulated by the dampers. The grate should be of such shape as will prevent clinkers from adhering to it, and thereby cause it to stick, preventing cleaning and at the same time partially stopping the admission of air which is so essential to the free combustion of coal.

The diaphragm plate is used to regulate the draft upon the fire, but does not increase the draft or suction through the flues, as many suppose. Care must be taken to have the apron, or lower adjustable plate attached to the fixed diaphragm plate, horizontal at its lower edge in order to have the fire burn uniformly transversely across the grates. Lowering this adjustable plate causes the fire to burn stronger at the front end of the grates, whereas raising the plate will move the strongest transverse fire line further back; but when this plate is properly adjusted, the coal will burn with nearly the same brilliancy over the entire surface of the grates. In adjusting this plate I prefer to place it in such a manner as will cause the fire to burn a little stronger or brighter at the front end, thus giving the unconsumed gases of combustion liberated from the coal at the rear end an opportunity of being consumed as they pass over the hotter fire at the front end. After this plate is adjusted properly for the average quality of coal, it should never be disturbed unless the engine is to burn continuously one grade of coal, when it should be adjusted for that special grade.

Many rely entirely on a small exhaust nozzle for a heavy draft, and thereby lose through excessive back pressure in the cylinders. Increasing the draft by narrowing the exhaust nozzle should be the last resort, after other means have been exhausted. The wire netting must be of a mesh sufficiently fine to prevent the cinders and sparks of large size from passing through, yet not be too fine to prevent the free escape of the smoke and gases. Again, it is essential that this netting be made from wire of sufficient size to make the maintenance economical. The usual netting used is 3×3, or $3\frac{1}{4} \times 3\frac{1}{4}$ meshes per inch, No. 11 to No. 13 wire, Birmingham gage. With this netting we get about 50% of opening for the gases and smoke to pass through, and care must be taken to have the netting of sufficient area to insure that the smoke and gases will have a free exit to the stack, otherwise it will choke the flues, and decrease the draft. The area of netting should be at least four times the area of flue opening.

With the old style smoke box equipped with low nozzle and lifting pipe, the netting is placed in the bonnet of the diamond stack, the lifting pipe being used to adjust the draft on the fire, and the diameter of same, together with the diameter of nozzles and stack, determining the amount of draft on the fire; with this device it is usual to place the bottom of the lifting pipe on a level with the nozzles, and regulate the draft by a sliding sleeve at the top. Reducing the diameter of the lifting pipe increases the draft, and enlarging this pipe decreases the amount of draft.

Care must be taken not to get the pipe so small that the exhaust steam will be retarded by friction along its circumference, and that the stack is of a size to permit the steam to expand and fill it without choking; much of this can only be determined by experiment.

The smoke box as a whole should be absolutely air-tight, except at the stack opening, in order to maintain the partial vacuum required to produce the necessary suction through the flues; especially is this required with locomotives equipped with extension fronts, for the following reasons: Sparks and cinders at high temperature are stored in the front, which are composed largely of unburnt coal and coke, requiring only a certain amount of the oxygen of the air to come in contact with them to produce combustion. If sufficient air be admitted through defective joints at the front end this mass will burn, thereby partially or totally destroying the draft on the fire through the flues, besides causing the extension front to become red hot, distorting the shell and increasing the difficulty of calking the joints to prevent a return of the occurrence.

Depositing Dredged Material at the Port of Rouen, France.

In a late issue of *Le Genie Civil*, M. RICHOU illustrates and describes a plan adopted at the new port of Rouen for conveying inland the material dredged from the basins. The dredging machine is of the type used on the Suez Canal, with a chain of buckets hoisting the mud, etc., to the top of a framed tower, and then discharging onto the land through a tube suspended from a mast on the dredger.

In this case floating tubes, as used in California and by MM. Couvreux & Hersent in France, were inadvisable, and a rise and fall of an 8-ft. tide had to be considered. The plan here adopted in filling low ground adjoining the river was to first put up a bulkhead at the water's edge and then to make two embankments parallel to the dredging ground and about 120 ft. apart. On each of these embankments, or on piling, rails were laid which carried framed towers supported on two railways trucks of 4 wheels each. These towers were from 20 to 27 ft. high, and were built in halves, so that there could be suspended in their center a light wooden Howe truss about 240 ft. long. This truss carried a metal trough, which was practically a prolongation of the pipe connected with the dredge. The trusses were suspended by adjustable chains running over pulleys in the top of the framed towers, and almost any grade desired could be thus secured by means of winches connected with these chains. At Rouen low land, extending over a width of about 400 ft., was successfully and economically filled.

PERSONALS.

Mr. SCOWDEN, City Engineer of Louisville, Ky., has resigned.

Mr. CHARLES DANNENHOWER has been elected City Engineer of Newport, Ky.

Gen. THOMAS SEDGWICK has been appointed Chief Engineer of the Harbor Board of San Diego, Cal.

Mr. ALEXANDER has been appointed President and General Manager of the Eastern Ry. of Minnesota.

Mr. CHAS. J. LUCK, trackmaster of the Chicago City Ry. Co., has been appointed General Superintendent, vice Mr. C. B. HOLMES, resigned.

Mr. J. H. WARDER has resigned his position as Chicago representative of the Pittsburg Testing Laboratory and has opened an office of his own.

Col. H. S. HAINES, General Manager of the Savannah, Florida & Western Ry., has been elected Vice-President, to succeed the late Mr. W. S. CHISOLM.

Mr. M. A. ZOOK has been appointed Superintendent of the First Division of the Louisville, New Albany & Chicago Ry., with headquarters at Indianapolis, Ind.

Mr. AUSTIN CORBIN, President of the Philadelphia & Reading Terminal Co., has resigned. Mr. A. A. MCLEOD, President of the Philadelphia & Reading R. R., has been elected to the position.

Mr. ARCHIBALD O. RONALDSON, Secretary of the Union Trust Co., died recently at Passaic, N. J. He was at one time a civil engineer in charge of bridge work on the Lehigh Valley R. R.

Mr. FRED. J. A. RICKON and Mr. CHAS. L. THOMPSON, of Little Rock, Ark., have formed a partnership to carry on business as architects and civil engineers. Their office is in the Allis block.

Col. ALBERT M. LEA, who had been connected with the surveys of Iowa, Minnesota, Wisconsin and other parts of the northwest, died at Corsicana, Tex., Jan. 16. He was a graduate of West Point.

Mr. F. PAUL DUBOIS, engineer, of Paris, France, has been in Richmond, Va., with Mr. A. LANGSTAFF JOHNSON, to make a more thorough investigation of the electric railway system than he did on his former visit.

Col. J. M. EDDY, receiver of the International & Great Northern R. R., died recently in California. He had been Assistant Chief Engineer of the Union Pacific Ry., Superintendent and Chief Engineer of the Omaha & Republican Valley R. R. in 1878. President of the Fort Worth &

Denver City Ry., and General Superintendent of the Texas & Pacific, the Missouri, Kansas & Texas and other Southwestern roads.

ARTHUR P. HERBERT, Mem. Am. Soc. C. E., late Chief Engineer Michoacan & Pacific Ry., has been appointed Engineer and Superintendent of the Colima division of the Mexican National Construction Co. Appointment dating from Jan. 15, 1891. Office, Colima, Mexico.

NEW PUBLICATIONS.

—*Building Stone in New York.* By JOHN C. SMOCK. Bulletin of the New York State Museum, vol. 2, No. 10. University of the State of New York, Albany, 1890. Large 8vo, pp. 200 and map.

A previous bulletin, published by the State Museum in March, 1888, treated of the quarry districts in New York State, their location, extent, geological relations, statistics and ownership of quarries of building stone. As might be expected much additional information has been collected since the issue of the first bulletin, and this matter is now here given in connection with a detailed treatment of the whole subject. The author first gives the general classification and arrangement of the building stones, and then deals with each group separately in its geological position and geographical distribution. Following this are the descriptive notes of quarries and quarry districts, in which the characteristics of the stone are generally given, in composition and adaptability to use. An interesting chapter is devoted to the use of stone in New York and other cities, followed by a long list of buildings, with the class and locality of the stone used and the date of erection noted. Prof. F. A. WILBUR reports on the physical and chemical tests of the chief building stones and shows the results of his investigations in tabular form. The durability of building stone and the causes of their decay close this useful publication.

—*Report on Prospective Tonnage of Traffic of the Nicaragua Canal.* By THOS. B. ATKINS, Secretary and Treasurer of the Maritime Canal Co. of Nicaragua. Pamph., pp. 27.

This is one of the most elaborate and, to all appearances, one of the most careful investigations of the vital question of the probable traffic of the Nicaragua Canal which has appeared. While necessarily open to the suspicion of possible bias, being prepared by an officer of the Canal Co., it gives a summary of all preceding investigations and certainly impresses one as a carefully studied and conservative summary. The final figures which it reaches, however, are astounding, being not less than 9,934,302 tons by 1897, with 11,729,583 more from which the canal may in some degree add to its revenue. The statistical data are given in much detail.

—*The Washington Bridge over Harlem River, New York City.* By W. R. HUTTON, Chief Engineer. For sale by LEO VON ROSENBERG, 35 Broadway, New York, and at this office. Price, $8, postage paid. This work was reviewed at length in our issue of Dec. 13, 1890, from the advance sheets. We can only add that the finished book confirms what we then said, that this is one of the most complete histories of a bridge, in text and illustrations, ever issued in this country. Its author was the chief engineer, and a civil engineer well known for the thoroughness of his work. As a consequence, the description is full, both from an historical and technical standpoint, and the illustrations tell the whole story by albertype reproductions of progress photographs, and by excellent detail drawings made, in most cases, directly from the finished bridge. It is a handsome and satisfactory production. The volume is 11½ × 9 ins., a wise departure from the usually unwieldy proportions of books of this character.

—*A Universal World's Exhibit.* By GEORGE MONTAGUE WHEELER, Major U. S. Engineers, Washington, D. C. In this pamphlet Major WHEELER gives a chart showing the ground plan of a world's exhibit arranged with an order of sequence and scientific system in such manner as to enable the visitor to readily follow out the progress of any one class of exhibits. Generally speaking he arranges the exhibits about a central source of power, in concentric circles, or in squares, rectangles, ellipses, etc., as the shape of the site may demand. These circles, etc., are then divided by radial lines into great divisions of commerce, agriculture, mining and manufactures. These are so arranged that by passing around the circle the inventions and allied features of all can be studied; or by passing out toward the circumference the group may be visited as a whole. The idea is generally a good one; but it is one that would be exceedingly difficult to work out in practice owing, for one thing, to the varying mass of exhibits in the several classes, and the almost certain lapping of one class of exhibits over others. The almost inevitable result of any attempt of this kind would be overcrowding in some sections and a waste of space in others; either feature highly objectionable in an exhibition of this class, from a commercial standpoint.

Advantages de la Haute Pression de la Vapeur dans les Machines Compound.—By M. A. LENCAUCHEZ; 8vo., pp. 13 An extract from the memoirs of the French Society of Civil Engineers, published in August, 1890. The paper is practically a discussion and continuation of a paper read in July by M. A. MALLET, on high pressure in compound engines.

Vital Statistics of Jews in the United States.—Census Bulletin No. 19, Washington, D. C. This is a report by Dr. JOHN S. BILLINGS, U. S. Army, on data gathered from about 10,000 Jewish families in this country. It treats of the birth, death and marriage rate of these people and general vital statistics, with the care and intelligence characteristic of the work of the well-known author.

TRADE PUBLICATIONS.

—*Injectors.* Rue Manufacturing Co., Philadelphia, Pa.—In the catalogue for 1891 sent out by this firm, we notice that ejectors of a capacity of 240 to 7,200 galls. per hour are among the standard articles listed. The size of steam pipe required to operate these ejectors varies from ⅜ in. for a flow of 4 galls. per minute to 2 in. for a flow of 120 galls. per minute.

—*Dump Cars.* Illustrated catalogue of dump cars, self-dumping tubs, wheelbarrows, trucks, hoists, etc. GEO. FOCHT, Hoboken, N. J.

SOCIETY PROCEEDINGS.

Wisconsin Polytechnic Society.—A new society, called the Wisconsin Polytechnic Society has been started among the engineers and architects of Milwaukee, with the object of advancing engineering and technical science. Membership is restricted to persons engaged in civil, military, mining, hydraulic, sanitary, electrical, mechanical and marine engineering, architecture, chemistry, geology and mineralogy. Toere are about 70 members and associates now enrolled. The admission fee for members and associates is $5, the annual dues are $10 for members and $5 for associates. The following officers have been chosen: President, G. H. Benzenberg; vice-presidents, J. B. Barr, Ed. Reynolds; secretary, E. F. Neukom; treasurer, J. A. Hathaway; trustees, Maj. C. E. L. B. Davis, W. G. Goodhue, H. C. Koch. The meetings will be held in Milwaukee.

Engineers' Club of Philadelphia.—Record of 15th annual meeting, Jan. 10, 1891. President H. W. Spangler in the chair, 49 members present. The following were elected officers for 1891; President, Wilfred Lewis; Vice-President, S. M. Prevost; Secretary and Treasurer, Howard Murphy; Directors, Rudolph Hering, Percival Roberts, Jr., F. H. Lewis, P. G. Salom, Geo. S. Webster. The retiring President, Prof. H. W. Spangler, delivered the annual address, outlining the various engineering achievements of the past year and the more prominent schemes proposed, and considered the question of technical instruction at considerable length.

The Secretary and Treasurer presented his annual report. The figures therein indicate that the club is in a thoroughly substantial and prosperous condition. An estimate of the finances indicates an increased balance of assets above that of last year.

Mr. Wilfred Lewis, the new President, then took the chair, with appropriate remarks. He specially urged earnest activity and energy in promoting the interests of the club on the part of every one, maintaining that the club should not be satisfied with its present position, and that there should be no limit to the expansion of its usefulness.

HOWARD MURPHY,
Secretary and Treasurer.

New England Railroad Club.—At the meeting on Jan. 14 the subject discussed was "What Constitutes a Defect in a Vertical Plane Coupler Sufficient to Condemn the Coupler?" The question was opened by Mr. F. D. Adams, of the Boston & Albany, whose remarks we condense as follows:

There is a wide difference of opinion in regard to the advantages of using the vertical plane coupler instead of the pin and link coupler. Here in New England we do not believe in the vertical plane coupler. The question under discussion to-night grew out of an order issued some time ago by Mr. Buchanan, of the New York Central R. R., giving instructions to car inspectors to refuse to receive vertical plane couplers with defects in the knuckles of any description, however minute. This order has caused some obstruction on the road and much agitation. The Central Railroad Club has appointed a committee to formulate a code of rules as to what defects in a vertical plane coupler knuckle are sufficient to condemn it. Mr. Buchanan and myself have agreed to leave our inspectors at Albany to decide what cars should be passed. I suppose what led Mr. Buchanan to issue the order was the breakage of common cast-iron drawbars when coupled to a vertical plane coupler of which the knuckle has been broken and has been removed. When a car with the knuckle broken is carded, the company is only liable for the knuckle, at an expense of about $4. But before the car runs many miles the cast iron draw bar will break, and that costs $8 to $10 to repair.

Now is it proper or safe to receive cars in interchange with defective knuckles? If so, how much of a break shall the inspectors be allowed to pass? A coupler with half an inch broken off at the top or bottom of the knuckle I would accept; but if both parts of the center are broken off half an inch, I should hesitate, because breaks of this sort increase the bending strain on the pin (when coupled with a common drawhead) and cause the breakage to extend.

Mr. Marden said that the Fitchburg R. R. had issued a similar order to the New York Central's, and was now enforcing it. He considered the different kinds of breakage to be so numerous that it was practically impossible to issue orders defining what might and what might not be accepted and he favored leaving the matter to the judgment of the inspectors. He considered that the experience of the New England roads and others which opposed the vertical plane coupler justified them in their position. "The different kinds of metal that are used in the construction of the head give very different results as to breakages. We have couplers offered to us cracked partly across on the upper side of the knuckle. That is said to be due, to a great extent, to the fact that the drawbar or hook instead of going out straight on a line with the car is sagged a little, or perhaps not up in place, and many times the connecting drawbar or hook on the opposite car will strike on the upper side of the knuckle."

Mr. Chamberlain (Boston & Maine), said:

Before this famous (by some called infamous) circular, to which reference has been made, was issued, Mr. Adams and I tried to agree as to what we would take in the shape of a defective coupler. We looked at a New York Central car in the East Boston yard, and saw a very slight crack in one of the coupler knuckles, so slight that we agreed that we would be willing to accept such a car. But when I looked through the pin hole I found the knuckle was ready to fall apart. Our greatest trouble has been from our connection with the N. Y. & N. H. R. R. About Oct. 25 last we had tied up at Northampton 40 cars with cracked knuckles, missing knuckles or broken bars, and in two weeks more there were 60 cars tied up from these defects. We finally agreed to receive cars in this condition, card them and put in a common vertical plane coupler. We are ready to receive cars from other roads on that basis.

From Oct. 15 to Dec. 31 we have either rejected or had rejected or found broken on our line 632 vertical plane couplers broken in various ways. These defects were divided as follows: Cracked knuckles, 155; broken knuckles, 154; missing knuckles, 85; common bars in place of vertical plane bars, 41; defects of vertical plane bars where the knuckle was all right, 51; defects other than those noted, 136. The Boston & Maine had two of these hook couplers, and broke one; did not buy any more.

Mr. Butler (N. Y., P. & B.) said his road had so far refused to receive vertical-plane couplers with any defects. "So many different kind of drawbars are used it is pretty hard to tell how much merit there is in this coupler. I would not receive any car with a defective coupler."

Mr. Robertson (C. Vt.) said his road had suffered seriously from defective knuckles. I have found very miserable stock put into them—blow holes in malleable iron, and I have found some knuckles which I almost mistrusted were cast-iron. My confidence in the vertical plane coupler is about gone. I did at one time think it was better than the link and pin coupler, even with the Safford improvement, but my experience with it has not confirmed that opinion.

Mr. Lauder (Old Colony) said that the only safe course was to reject all couplers with any defects, since some of the most disastrous accidents on record had been caused by breakage of drawbars.

I believe the only way that the railroads of the country can get clear of this vertical plane coupler is to strictly enforce similar rules to that first adopted by the New York Central—refuse to receive cars with such couplers unless in perfect order. If that is done all over the country, the life of the vertical plane coupler will be exceedingly short. If every defective coupler or drawbar caused the stoppage of the car until the owner was notified and until he furnished a new knuckle or drawbar, the matter would come to the attention of the managers, and they might be surprised that the detentions were so often caused by this so-called Master Car Builders' coupler. This coupler has been foisted upon the roads by the mechanical papers, not only by advertising, but by procuring the writing of editorials, to make the managers believe that this coupler was a panacea for all the ills we are troubled with in the interchange of cars.

The experience of the last two years has proved that the most dangerous thing on our roads is this coupler; and I trust that some organized effort will be made toward rescinding the action taken by the Master Car Builders' Association some years ago; action taken honestly, because they thought that type of coupler held out something better than we had before. I think the unprejudiced men at the head of the mechanical departments of the railroads of this country would almost unanimously, were it not for their pride, condemn that coupler; but of course a man does not like to admit that he has made a mistake. That coupler has got to be abandoned, because of its danger. It is the most dangerous appliance trainmen have to handle, due largely to the fact that it has to couple with a variety of couplers. With about a million cars in this country, it will take years and years to get them equipped with any standard appliance. It has taken 15 years to secure the adoption of a standard height of drawbar, and even now we have to receive cars with the drawbars 6 ins. higher than the standard.

Mr. Adams said he was in favor of refusing all vertical plane couplers with any imperfection, and had only proposed a modification thinking it might be more acceptable to the majority. He gave the following figures as the cost of repairing vertical plane couplers on the Boston & Albany for the three months ending Dec. 31, 1890: The different couplers are designated by numbers: No. 249 has cost $639.81; No. 248 has cost $2,168.68; No. 333 has cost $1,334.30; No. 334 has cost $222.25; No. 255 has cost $80.85; unknown, that is, couplers broken and the name not given, $144, making a total of $4,389.89 for keeping up these couplers for three months on the Boston & Albany. One common cause of breakage is from ignorant trainmen trying to couple the cars with the knuckles closed.

Messrs. Sinclair and Barnes defended the vertical plane coupler, claiming that where breakages were due to improper handling the proper remedy was to teach the men how to handle the cars.

Mr. Griggs (N. Y. & N. E.) said that if he had his way he would not take a car with a vertical plane coupler, either broken or perfect. Mr. Adams, in reply to a question, said the cost of links and pins on the Boston & Albany R. R. in 1890 was $6,375. Mr. Marden said he hoped that it would not be understood that the New England roads in opposing the vertical plane coupler were not progressive. He believed every railroad man would be glad

to see a different form of coupler from the link and pin in use on all cars, and that the time would come when a uniform coupler would be in use. On motion of Mr. Adams it was voted that Mr. Buchanan's order directing the refusal of all vertical plane couplers with defective knuckles be approved by the club. Some comment on the above discussion will be found on our editorial page.

At the next meeting on Feb. 11 the subject for discussion will be "Painting and Varnishing of Railroad Rolling Stock."

American Society of Civil Engineers.—The annual meeting was held Jan. 21, President Wm. P. Shinn in the chair and a larger number of members present than usual, the use of a chapel adjoining the Society's house being required for the regular proceedings. The first business was the appointment of J. G. Van Horne, J. B. Johnson and J. G. Dagron as tellers of the ballot for officers; the latter being called away before the work was completed, H. B. Seaman was appointed in his place.

The report of the Committee on Revision of the Constitution and By-Laws was first presented, and after the meeting had authorized two slight alterations in the proposed draft, Mr. Shinn, as chairman of the committee, referred to the difficult task of the committee, and the careful and thorough way in which it had done its work. Numerous conflicting suggestions had been made, and there were at first wide differences in the committee, but these had been narrowed down by a process of elimination, and the report was a unanimous one, except that Mr. Strobel differed from the rest on one or two points. The report was accepted and the committee discharged with the thanks of the Society.

The constitution as finally reported by the committee was then discussed. The discussion occupied the greater part of the morning and the whole of the afternoon session, and resulted in some changes being adopted which will be made before the proposed constitution is submitted to letter ballot. There was considerable discussion over the proposal to create a new grade, that of Associate Members, but it was considered there should be a professional grade between Juniors and the full grade of Members, the Associates being non-professional men. It was also moved that they should not be corporate members, or should have the right to vote but not to hold office, but these motions were lost. No more Corresponding Members are to be appointed; the Society decided this some years ago, but the three remaining members of that grade will retain their rights. A motion by Prof. J. B. Johnson was adopted to the effect that the performance of the duties of a professor of engineering in a technical school of a high grade, shall be taken as equivalent to an equal number of years of active practice. Also a motion by Mr. T. C. Clarke, in regard to expulsion, providing that a member advised of charges against him, may present a written defense, which shall be considered at a meeting of the Board of Directors of which he shall receive notice and at which he may attend in person. Over the article relating to officers there was considerable discussion; it was proposed that the past-presidents should not be members of the Board of Directors, but it was considered as a slight honor conferred for their having served the Society, and that their advice and experience would be very valuable in matters of government, while it would make the Board more representative of the various sections of the country. Mr. Peterson stated that this plan was adopted in the Canadian Society of Civil Engineers. The clause restricting the eligibility to the position of President was struck out, but motions that the President should be eligible for re-election were lost. The main discussion was as to whether the Secretary should be elected by the Society and should be a member of the Board of Direction, or whether he should be appointed by the Board as their employee. Several members advocated the latter plan. The committee's idea was that owing to the fact that the President and Vice-Presidents could not give their time to the affairs of the Society, the Society should be represented by a Secretary, who is one of the Trustees and a member of the Board of Direction. This view prevailed and the provision of the proposed constitution in that respect remains unaltered. Mr. Boller thought there should be a clause providing that the Secretary shall give his whole time to the Society; Mr. Cooper thought this should be inserted as soon as the Society can afford to pay for his whole time. It was pointed out that provision is made for an Assistant Secretary, who would carry out the routine work, and who is to give his whole time to the Society. No alterations were made in this respect. There will be more conservatism in future in appointing special committees. In regard to nominations for officers, the last five Past Presidents are to be members of the nominating committee. The vexed question of requiring ballots for membership to be enclosed in two envelopes was disposed of on motion of Mr. J. F. Flagg, by altering the clause to read that ballots "may" be enclosed in two sealed envelopes; Mr. Cooper pointed out that persons could not legally be compelled to vote secretly, and if he chose to use only one envelope and endorse it, his vote would be legal. On motion of Mr. Oberlin Smith voters may change their votes on making a written request to that effect. The proposed article relating to "Local Associations" will be balloted for separately.

The report of the tellers appointed to canvass the ballot for officers showed 711 votes cast, of which 695 were counted. For president, Mr. Chanute received 690 votes. For secretary, Mr. Collingwood, 481; Mr. Trautwine, 214. For treasurer, Mr. Bogart, 456; Mr. Boller, 428. For directors, Mr. Brush, 461; Mr. Childs, 221; Mr. Hering, 603; Mr. Bogue, 113; Messrs. North, Herschel and Whinery, 688 each. The following officers have been elected for the current year:

President, Octave Chanute.
Vice-Presidents, Alphonse Fteley, Charles Hermany.
Secretary, Francis Collingwood.
Treasurer, John Bogart.
Directors, Samuel Whinery, Clemens Herschel, Edward P. North, Rudolph Hering, Charles B. Brush.

The Norman medal has been awarded to Mr. John R. Freeman for his paper on "Experiments Relating to Hydraulics of Fire Streams" (Transactions Am. Soc. C. E., Nov., 1889). The Rowland prize has been awarded to the paper on "The Sibley Bridge" by O. Chanute, J. F. Wallace and W. H. Breithaupt (Transactions Am. Soc. C. E., Sept., 1889).

At the evening session the first proceeding was the presentation of the majority report of the Committee on Uniform Standard Time, by Mr. Sandford Fleming, chairman of the committee. In regard to the memorial to Congress on the question of standard time, 226 votes were received for and 7 against the memorial; a bill has been prepared and the matter referred to committees in both Houses of Congress. The number of railway officers who have directly approved the new system is as follows: 135 presidents, vice-presidents and general managers; 77 general superintendents; 114 superintendents; 12 general traffic managers, and 65 engineers; a total of 403 officers, representing 110,000 miles of road. The 24-hour system has been adopted on the railways of India, and is to be adopted throughout the British possessions. The report was accepted, and printed copies will be submitted to the General Time Convention and to railway authorities. The committee was continued. Mr. F. Brooks presented a minority report, which will be published in the proceedings of the meeting.

The report of the Committee on Units of Measurement was read by Dr. Egleston; it recommended that the committee be authorized to unite and co-operate with other committees appointed for a similar purpose by other societies; also that the "Henry" be adopted by the Society as the unit of electrical self-induction, and that steps be taken toward ascertaining the exact value of the Troy pound weight now in the mint at Philadelphia. The report was received, its recommendations were approved, and the committee ware continued.

The Committee on Compression of Cement and Compressibility of Masonry was discharged on motion of Mr. Collingwood, chairman of the committee. The Committee on Uniform Methods of Testing Materials for Metallic Structures reported progress and was continued. The Committee on Standard Rail Sections also presented a progress report and was continued. Mr. Fteley, of the Committee for Securing Information as to Impurity of Water Supply, stated that it had been found that a committee of the American Water-works Association had covered the ground proposed for the committee; at his suggestion the committee was continued and authorized to correspond with the various bodies interested in the purity of water supply to see if they would contribute a sum toward the establishment of a central bureau for the consideration of data and information in this connection. The Committee on the International Engineering Congress reported that such a convention should be held at Chicago, in connection with the World's Fair, in 1893. The report was accepted and the committee discharged. There will be a central office for representatives of the several societies, and the American Society of Civil Engineers will appoint two members.

A cordial vote of thanks was tendered to Mr. John Bogart, in recognition of the valuable and efficient service he has rendered the Society during his 13 years tenure of the office of Secretary. A vote of thanks was also tendered Mr. Wm. P. Shinn.

The proceedings terminated by the presentation of a short paper on "The Chignecto Ship Railway," by Mr. J. F. O'Rourke; the paper was illustrated by stereopticon views showing the progress of the work. The Society then adjourned.

REPORT OF THE BOARD OF DIRECTORS.

The following is an abstract of the report: On Jan. 1, 1891, the membership is as follows:

	Resident.	Non-resident.
Honorary members	4	3
Corresponding members		3
Members	200	880
Associates	17	44
Juniors	57	158
	278	1,088
Total resident and non-resident		1,366
Fellows, 56, of whom 5 members are included above, leaving		51
Subscribers to the Building Fund, 140, of whom 83 are entered in one or other of the above classes, and 19 are deceased, leaving		38
Total connected with the society, Jan. 1, 1891		1,455
Total connected with the society, Jan. 1, 1890		1,335

The additions during the past year have been:

Members	87
Associates	6
Juniors	56
Fellows	1
Total additions	150

The decrease during the year in each class has been:

	Total.
Honorary Members, died, 1	1
Members died; 15; resigned, 2	17
Juniors: resigned, 1; trans. to M., 8; trans. to As., 1	10
Fellows; died, 1	1
Subscribers; died, 1	1
Totals: Deaths, 18; resignations, 3; transfers, 9; Total	30

There has thus been an addition of 150 and a decrease of 30, making actual net increase during the year 120. On Jan. 1, 1890, there were 54 proposals pending; 165 proposals have been received during the year; 92 candidates have been elected members, of whom 8 were transferred from Juniors; 6 candidates have been elected as Associates, of whom one was transferred from Junior; 54 candidates have been elected juniors; one candidate has been elected a Fellow. During the year 87 persons have qualified as Members; 6 as Associates, 56 as Juniors, one as Fellow; 12 candidates elected during the year as Members and 3 as Juniors, have not yet qualified. There are 29 proposals now pending.

The Transactions of the Society during the past year have been issued in 2 volumes, and contain 794 pages and 158 plates. The Proceedings have been issued in 1 volume and contain 235 pages. The index to the Transactions from their first issue to the present year has been made by Mr. John Bogart, Secretary.

The library has been increased during the year by the following additions:

Books and pamphlets	322
Maps, plans, drawings, charts, photographs and engravings	178

The Society has lost by death, during the term covered by this report, 1 Honorary Member, Wm. J. McAlpine; 15 Members, Charles Ackenheil, Theodore Allen, Wm. H. Atwood, Morris S. Belknap, O. E. Cushing, J. L. Gillespie, Fred Graff, B. H. Green, Samuel Keefer, Wm. B. Knight, F. A. Leers, O. E. Michaelis, Wm. H. Paine, F. Floyd Weld and Thomas J. Whitman; 1 Fellow, F. C. Lowthorp.

During the year 21 meetings were held, including the annual meeting in New York and the annual convention held at Cresson, Pa.; 13 meetings of the Board of Direction have been held.

The committee appointed to consider a revision of the Constitution and by laws of the society, presented in November, 1889, a report of progress and a codification of the then existing constitution and by-laws, with no amendments except as to the amending clause. This codification was duly adopted by letter ballot, and is now the constitution of the society. The committee has also duly submitted, on the first Wednesday of November, 1890, a fully revised constitution, and this revision, with the report of the committee has been mailed to the members and will be in order for consideration at this meeting.

REPORT OF THE TREASURER.

The following is an abstract of the Treasurer's report.

Receipts.

Balance on hand, Dec. 31, 1889.		
Fund for enlarged building	$3,845.50	
Fellowship fund	526.46	
Several funds	6,552.49	$10,924.45
Entrance fees		3,620.00
Current dues	13,080.00	
Past "	1,177.50	
1891 "	3,865.00	18,122.50
Sales of publications		1,345.42
Certificates of membership		165.50
Advertisements		917.00
Interest, compounding dues, etc.		1,558.52
Total		$36,654.39

Disbursements.

Interest on mortgage	$ 800.00	
Taxes	453.10	
Publications	13,614.61	
Stationery and printing	1,106.16	
Postage	2 826.56	
Library	1,193.16	
Salaries	3,000.00	
Convention and annual meeting	1,347.39	
Janitor, house supplies, fuel, water and gas	1,484.37	
Certificates of membership	115.25	
Insurance	54.62	
Rowland Prize	58.00	
Finance, Treasurer's books, accounts, collections	1,200.00	
Work of committees	667.86	
Improvements on Society house, in excess of amount in Building Fund	162.80	
Other expenditures	579.85	
		$28,663.53
Payment for enlargement of Society house, being balance of Building Fund		5,425.50
Balance in bank and trust company		2,565.36
		$36,654.39

ENGINEERING NEWS

AND

AMERICAN RAILWAY JOURNAL.

Published Weekly at Tribune Building, New York.

Vol. XXV. Saturday, January 24, 1891.

D. McN. STAUFFER, A. M. WELLINGTON.....EDITORS
CHAS. W. BAKER, E. E. R. TRATMAN, M. N. BAKER, F. P. BURT, } ASSOCIATE EDITORS
GEO. H. FROST.....BUSINESS MANAGER

SUBSCRIPTIONS.

To United States, Canada, and Mexico.

One Year, **$5.00;** *6 months,* **$2.50;** *4 months,* **$2.00;** *single Copies, 12 cents. To all* **Foreign Countries** *in the Postal Union, add $2.08 to above prices for postage.*

CLUB RATES.

Two new subscriptions	$9.00
One renewal and one new subscription	9.00
Five new subscriptions	20.00
One renewal and four new subscriptions	20.00

Subscribers *can have the mailing address of their paper changed as often as they desire. Send both the old and the new addresses.*

The date *when the subscription expires is on the address label on each paper, the change of which to a subsequent date becomes a receipt for remittance.* **No other receipt** *is sent unless requested.*

Advertising rates, 20 cents per line *agate measure. Schedule sent on request.* **Changes** *of advertisements must be in hand on Tuesday afternoon; New advertisements Wednesday afternoon;* **Transient** *advertisements not later than Thursday noon. The last pages go to press early on Friday, and we shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay.*

Drawings and Photographs *of all new engineering works or designs, large or small, of interest from their magnitude, novelty, or originality, as well as newly adopted* **Standard Plans** *for engineering structures or details, rolling stock, etc., are always desired for early publication. Also* **Brief Technical Notes** *of the cost or manner of executing work, tests of materials, machines or other new devices, and* **News of New Construction** *of all kinds.* **Letters** *for publication must be accompanied by the name or card of the writer.*

COMING TECHNICAL MEETINGS.

Denver Society of Civil Engineers.—Next meeting, Jan. 27. Secy., Geo. H. Angell.

Illinois Society of Engineers and Surveyors.—Annual meeting, Jan. 28-30, at Springfield. Secy., S. A. Bullard.

Civil Engineers' Society of St. Paul.—Next meeting, Feb. 2. Secy., G. L. Wilson.

Rensselaer Polytechnic Institute Alumni.—Midwinter reunion at Kansas City, Mo., Feb. 2 and 3.

Western Society of Engineers.—Next meeting, Feb. 3. Secy., J. W. Weston, 230 La Salle St., Chicago.

Civil Engineers' Association of Kansas.—Next meeting, Feb. 4. Secy., J. C. Herring, Wichita, Kan.

Engineers' Club of St. Louis.—Next meeting, Feb. 4. Secy., W. H. Bryan, 30 South 7th St.

American Society of Civil Engineers.—Next meeting, Feb. 4. Secy., Francis Collingwood, 127 E. 23d St., New York.

Technical Society of the Pacific Coast.—Next meeting Feb. 6. Secy., O. von Geldern, 408 California St., San Francisco.

Engineers' Club of Philadelphia.—Next meeting, Feb. 7. Secy., Howard Murphy, 1122 Girard St.

Civil Engineers' Club of Cleveland.—Next meeting, Feb. 10. Secy., A. H. Porter, 50 Euclid Ave.

New England Railroad Club.—Next meeting, Feb. 11. Secy., F. M. Curtis.

Engineering Association of the Southwest.—Next meeting, Feb. 12. Secy., Olin H. Landreth, Vanderbilt University, Nashville, Tenn.

Northwestern Track and Bridge Association.—Next meeting, Feb. 13. Secy., D. W. Meeker, St. Paul, Minn.

Western Railway Club.—Next meeting, Feb. 17. Rooms, Phenix Building, Chicago. Secy., W. D. Crosman, 816 Rookery Bldg.

Engineers' Society of Western Pennsylvania.—Next meeting, Feb. 17. Secy., S. M. Wickersham, Pittsburg, Pa.

Boston Society of Civil Engineers.—Next meeting, Feb. 18. Secy., S. E. Tinkham.

Northwest Railroad Club.—Next meeting, Feb. 19. Secy., H. F. Robinson, St. Paul, Minn.

New York Railroad Club.—Next meeting, Feb. 19. Rooms, Gilsey House. Secy., H. G. Prout.

Engineers' Club of Cincinnati.—Next meeting, Feb. 19. Secy., J. F. Wilson.

Vox populi, vox dei. The election in the American Society of Civil Engineers has resulted in a decided and emphatic victory for the present management, which is virtually continued unchanged. Had the election been close or the majority been smaller it might have been possible to assume that the result had been changed by the opinion of the Board of Direction adverse to the eligibility of Mr. TRAUTWINE, or by a more energetic and more carefully managed canvass, or by the fact that a flood of circulars against what was alleged to be a "rev olutionary" movement was counterbalanced by only one circular on the other side. But the fact that Messrs. COLLINGWOOD, BOGART and BRUSH were all elected by an average majority of somewhat over two-thirds, and that Mr. TRAUTWINE ran only slightly behind his ticket, forbids the assumption that the result was determined, even if the size of the majority was affected, by any such causes. The vote may fairly be claimed as an emphatic endorsement of the past management and policy of the society, and a vote for its continuance unchanged, and in substantially the same hands, and as such it will be universally interpreted. The result foreshadows the adoption of the new constitution, which is drawn upon these lines, retaining and even emphasizing those features of the old constitution which have excited most criticism among the dissatisfied element. It also foreshadows the rejection of even the cautiously drawn article which proposes to make a small beginning in the way of decentralization by authorizing the formation of local associations.

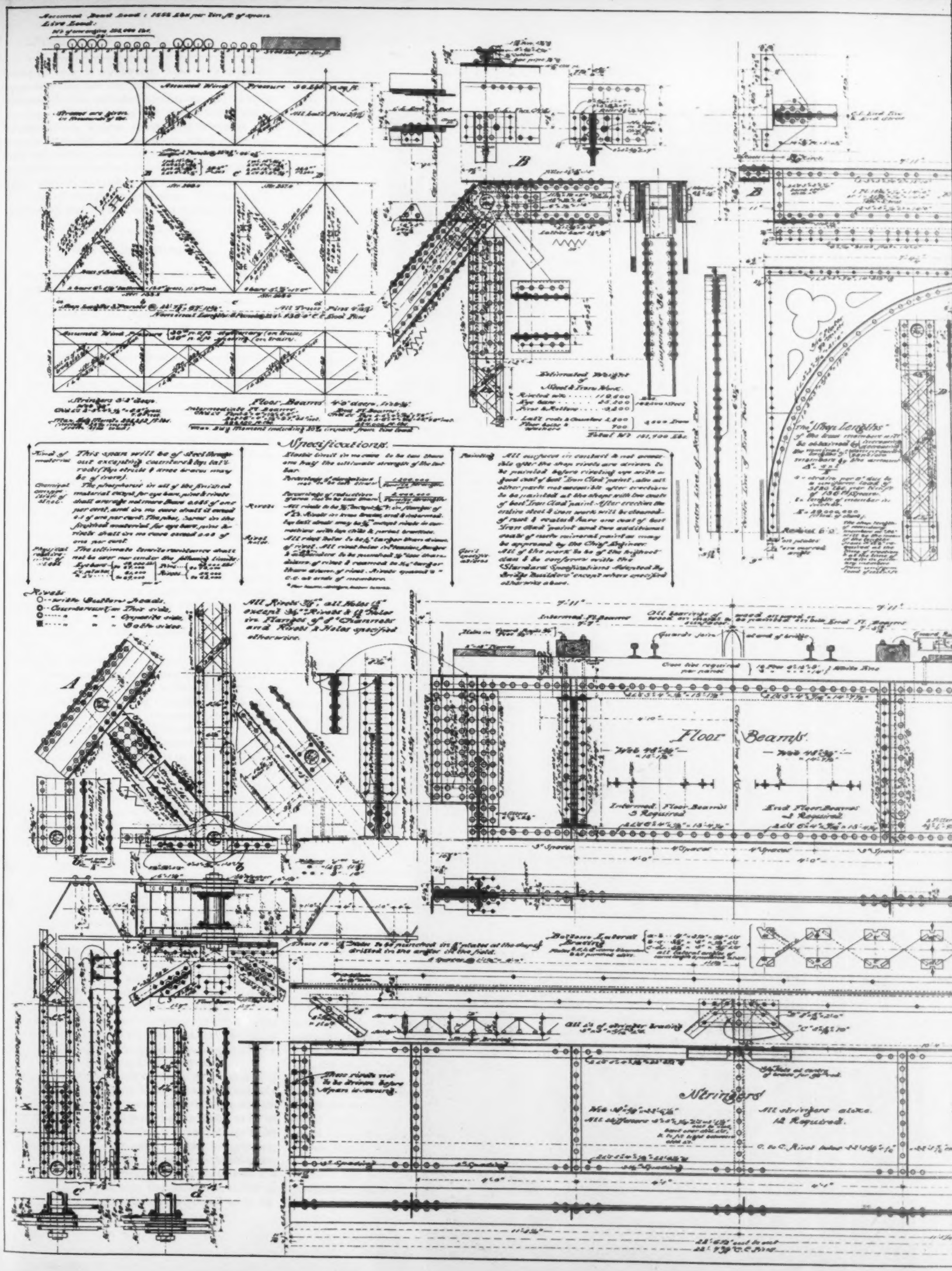
A PAPER on "Car Service," which was read at the meeting of the New York Railroad Club, on Jan. 15, by Mr. W. G. WATTSON, Division Superintendent of the West Shore R. R. (and a brief abstract of which was given in our issue of Jan 17), deals ably with a great evil, and makes (or rather repeats) a proposal which appears to us to outline by far the best plan of remedying it. The case is stated as follows :

> We have over 1,000,000 freight cars in service, and the average performance is from 17 to 25 miles per day. In other words, these cars are in motion, on an average, less than 2 hours of each day. Cars should average at the very least 40 miles per day. Were this average secured 500,000, or one-half the present number of cars, would be sufficient to meet the demands of transportation. On this basis the cost of the surplus cars, side tracks, motive power, etc., represents a needless but permanent investment of over $290,000,000 and an additional yearly expenditure of $23,000,000, without including interest on the money. From this you will see that the question of car service involves an interest of vast magnitude.

The Car Accountants' Association was the first to call attention to the evils of the present system. In 1885, Mr. ALBERT FINK, then Trunk Line Commissioner, undertook to introduce the mileage and per diem system of charges, but it was inaugurated before the coöperation of sufficient companies had been obtained, and after 6 months' trial was discontinued. The General Time Convention has been trying for three years to again start the same system. The American Society of Railroad Superintendents has also taken up the subject, having in view the improvement of the service by the development of better methods for handling the cars. Mr. WATTSON thinks, however, that if the three plans of per diem charges, demurrage charges and systematic methods of operating, were all successful, the service would be improved, but still unsatisfactory, owing partly to the large empty movement that would follow. Yet these plans are the leading features of any car service system. The plan suggested by Mr. WATTSON, is that all the cars owned by railways comprised within a certain geographical district should be pooled in an equipment company or trust. The stock of the company would be held exclusively and in perpetuity by the railways within its territory, and would be allotted to them on the basis of the average number of tons of freight handled per mile of road operated. A reapportionment of the stock to be made every two years, on the original basis of tonnage per mile. The affairs of the company would be in charge of a board of directors composed of representatives of the several roads in the territory. The plan contemplates the collection of demurrage charges on consignees and per diem charges on the railway companies for the use of cars.

THE plan suggested of taking the freight car service from individual roads and turning it over to a few equipment companies operating over an extensive territory is not entirely new, as above stated, but Mr. WATTSON, in this paper, goes into the details of the plan more closely than has been done before. The idea of having a comparatively few equipment companies, each operating a separate territory, follows closely upon the lines of the very evident tendency toward the consolidation of the railways into a few comprehensive systems, and it is possible that the establishment of great freight car service systems may precede and bring about the complete consolidation of such railway systems. While the plan plainly offers certain great advantages, more especially in economy of operation, it could not be introduced without a good deal of trouble and preliminary detail work. Considerable complication would also arise in transferring the title to cars covered by car equipment trusts or railway mortgage bonds; but this would be but temporary. It may also be questioned whether the plan, if operated on the lines of economy, would be found sufficiently elastic to be satisfactory to the railways in providing for the prompt handling of irregular and varying quantities of freight from different centers, since the railways would have to make a requisition on the equipment company for all cars needed or likely to be needed, and would then pay a per diem charge on these cars. There is great need of some improved method of car service in the interests of all parties, and the question of what particular plan to adopt should not be allowed to remain in abeyance indefinitely.

JUDGING from the present activity among engineers, capitalists, law makers and promotors, there is an immediate and hopeful prospect for the inauguration of some satisfactory scheme for better rapid transit facilities in this city. Of all the many plans presented those proposing deep tunnels seem to have the most points in their favor, and the Metropolitan Underground Railway Co., the latest in the field, presents, to start with, the array of men and capital necessary to successfully carry out a scheme of the gigantic proportions outlined. According to published accounts, the investigations already made by this company show that solid rock would be met with over very nearly the whole route suggested at a distance of about 100 ft. below the street level. This feature should much facilitate construction, and the estimate submitted for the tunnel work alone seems liberal. The one objection to this plan is its double track feature, confining the use of the line to local traffic only, and not providing for what is really rapid transit in this day—a through line to distant points with the minimum of stopping points within the city, or on the lower end of the line, at least. As a rule passengers would prefer daylight for transit. But a well lighted, well ventilated tunnel, with a motor to trains that will not emit smoke or gas, is by no means an objectionable plan. Access to such a tunnel is now readily secured by the perfection and capacity of the American elevator system. But the chief consideration that would lead us to favor such a scheme is that it practically eliminates all question of surface obstruction during the building, and does away with the equally serious conflict concerning the disposal of surface property and the location of surface routes. Another advantage of the deep tunnel is the com-


Specifications.
Floor Beams
Stringers
All Rivets ¾", all Holes ⅞" except 1" Rivets & 1⅛" Holes in Flanges of 4" Channels and Rivets & Holes specified otherwise.
Bottom Lateral Bracing
Floor Beams
Stringers
All stringers alike.
12 Required.

Details as shown are General details applied to 136 Ft Span.

Forked Heads:
Connections with Forked Heads of Top Lateral Rods are preferred, provided the forked heads are made on the original bars by the following method:

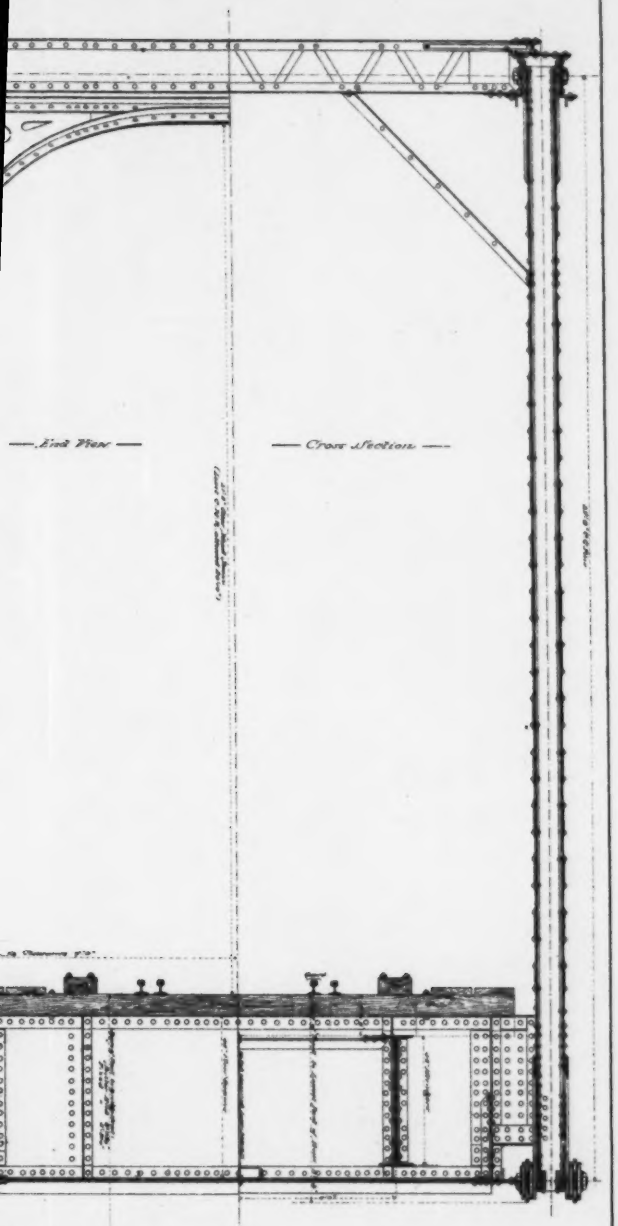
Increase the metal in the original bar by upsetting where the welds are to be made. Flatten with short blows with a light steam hammer from a point just beyond where weld will come to near the end of the bar, taking care that the flow of the metal longitudinally does not reduce the original bar section more than 20%. Mark the loop eye in the ordinary manner, then split with a hot saw, thread & shape the forked head.

Chisel may be used for splitting instead of hot saw, where the splitting would be done before tapping.

The adjoining sketch shows the detail of connection used with rods having forked heads.

CHICAGO, KANS
AT
DETAILS O

W. E. WINNER, PRESIDENT.
J. R. CHAPMAN, CHIEF ENGINEER.
W. E. HANSON, ENGINEER AND SUP



, KANSAS CITY & TEXAS RY. BRIDGE
AT SMITHVILLE, MO.
TAILS OF 136 FT. THRO'--SPAN.

NT. — FRANK D. MOORE, CHIEF ENGINEER BRIDGE DEPT.
NGINEER. — WM. F. WAAG, CHIEF ASS'T ENGINEER BRIDGE DEPT.
R AND SUPT. — KEYSTONE BRIDGE CO., CONTRACTORS.

CHAS. HART & SONS, LITH., 88 VESEY ST., N.Y.

parative ease of connecting New York with its neighbors, beyond the East and North rivers, as contrasted with elevated structures and bridges for these waters. If the first tunnel under either of these rivers is once successfully driven, it will only be a matter of a short time when other tunnels will follow; and the whole solid substratum of the city is open to the location of lines connecting these several tunnels with a main trunk line regardless of surface occcupation. The outlook is interesting and hopeful for deep tunnels at least.

World's Fair Prospects.

The opening of the great world's fair which it is proposed to hold in Chicago in the summer of 1893 is now but little more than two years off. The date when it was originally proposed to open the fair, when New York and Chicago and other cities were contending for the privilege of holding it, is now but little more than a year off, which illustrates how utterly futile it was to even hope to open the fair at that date, as we said at the time.

Unless greater care is exercised in the future than has been in the past to avoid delays, it soon may be as nearly impossible to open the fair in the 1893 as it was then to open it in 1892, for, although many of the vexatious preliminaries which always consume much time have been disposed of, yet the rate of progress so far in making ready for the great event has been painfully slow. Absolutely nothing, in fact, in the way of definite work, even on the final plans, still less on their execution, has yet been done. So far the course of events has been as follows:

The bill authorizing the holding of the fair in Chicago was approved April 25, 1890. It specified for the appointment of a large Board of Commissioners, two from each State and territory and eight at large, with as many more alternates, the said Commission being empowered to accept a site, as soon as one deemed adequate was tendered, and the sum of $10,000,000 was secured; and it practically appropriated $1,500,000 in all ($400,000 for a government building) as a government contribution. The Commission was duly appointed and met and organized at Chicago, within a month thereafter, June 26.

Two days thereafter the Commission was duly organized, with THOS. W. PALMER, of Michigan, as President, and Col. GEO. R. DAVIS, of Illinois, as Director-General. There are five Vice-Presidents and a Secretary, an Executive Committee of 26, and 21 committees of 5 to 16 members each, an ample staff of officers. There is also a large Board of Lady Managers. There is also a local corporation, known as the "World's Columbian Exposition," with a full staff of officers.

Then began the "battle of the sites" with all its allied questions, which is not even settled yet. The north, west and south sides each desired the fair, very naturally, with a considerable party in each disposed to compromise on the central or "lake front" site, directly opposite the business center of the city. It was finally decided to compromise by putting part of the exposition (how much is not yet settled) on the lake front, and the remainder in Jackson Park, a fine and nearly level (of course) tract on the lake shore, about 7 miles south of the center of the city. About 400 acres (more if necessary) is here available, about 120 acres of which is to be covered with buildings.

Even the ground plan of these buildings and of the exposition generally is not yet settled; the only thing settled about it being that the approximate ground plans already published are liable to be so considerably modified that it is not yet safe to let the grading. Consequently, bids for grading which have been invited will be withheld or returned. A board of eminent architects, who are between them to design the buildings, is now in session at Chicago, which is supposed to be determining this ground plan and the general outline of the buildings, after which they will separate and prepare their several designs.

This method, so far as we now recall, is quite different from any which has ever before been adopted. It may prove a great success, but it would seem to have the elements in it for a possible conspicuous failure. The architects selected are certainly as good a list as could be readily made up. They were elected only on Tuesday, Jan. 6, and are as follows:

New York: GEO. B. POST, R. M. HUNT, MCKIMM, MEADE & WHITE.

Boston: PEABODY & STEARNS.

Kansas City: VAN BRUNT & HOWE.

Chicago: ADLER & SULLIVAN, S. S. BEMAN, W. L. B. JENNEY, BURLING & WHITEHOUSE.

The great architectural firm of BURNHAM & ROOT, of Chicago, are the consulting architects, and Mr. A. GOTTLIEB is the Consulting Engineer. But the sudden and lamented death of Mr. ROOT, perhaps the most gifted and brilliant man in the whole list, and the man who had in charge more than any other one man the general supervision and "unifying," so to speak, of the exposition, leaves a great gap in this list, which it will be difficult, if not impossible, to adequately fill. Still, no better architectural ability can be had, probably, than is contained in the list; all are eminent men, but none have had prior experience with large expositions, we believe, and the task cut out for them is a tremendous one. They must agree in a few days on the general and detailed ground plan and the general outline and style of the main buildings at least, separate and prepare designs, have them passed upon and accepted by the entire body, and be ready to start work on some of the larger ones, at least, next spring. In the meantime the necessary grading is to be done during the present winter. It will not be greatly hindered by frost, as it is chiefly dredging out lakes and channels, and putting the material on the adjacent flat surface. If the main buildings are started, say by May 1, 1891, there will be just two years in which to erect and fill them with exhibits. If, as would seem much more likely, the actual work of construction cannot be begun until late in the summer or fall, the available time will be correspondingly reduced.

Still, within the shortest period stated, the needed work can doubtless be done, but it will be very close work, and it will greatly redound to the honor of the management and architects if there is not a certain crudeness and lack of harmony in the general effect. A year at least is none too great a time for the mere studying of the plans, especially with so many different *chefs*, whose ideas of cookery are quite sure to differ. Mr. FRED. LAW OLMSTEAD is acting as landscape architect, and this alone goes far to insure that the grouping of the buildings and arrangement of the grounds will be what they should be.

It begins to seem altogether probable that no great changes will be made along the lake front, and that the Illinois Central tracks will not be interfered with; but it is deemed quite certain that on the considerable park space which now exists and is available between those tracks and the first city street (Michigan Avenue) a permanent art building, and probably a great music hall and electrical exhibit will be placed, where a large night attendance is not unreasonably expected.

In the meantime, the problem of how to handle the great crowds which are sure to be attracted, is already receiving serious attention. At least 20,000,000 visitors are expected (there were 28,149,358 at Paris), with as many as half a million on single days. Consulting Engineer GOTTLIEB, and Messrs. RODD, WHITTEMORE and CORTHELL representing the railways, have had prolonged conferences this week, and have already prepared preliminary plans, the publication of which was unauthorized and premature, but which, nevertheless, may be taken as fairly outlining the general course of the future.

They decide, as it would seem as if any rational being must, that to handle great crowds some form of loop is the only defensible plan, and they estimate that the station, loop and elevated approaches will cost something like $1,900,000, it being necessary to provide for a crowd of 110,000 per hour, or 138 8-car trains per hour. If 20,000,000 visitors pay 10 cents each to ride over these tracks the receipts will be only $2,000,000, but the Illinois Central tracks, which surround the grounds on the land side will carry perhaps a third of the visitors, so it is justly regarded as questionable whether the railways can afford to incur such large expenses for the probable return. The end to be feared is that inadequate facilities will be provided to save this risk, and hence that the attendance will be greatly checked. There is still ample time to avoid this danger, and Chicago, if any city, has enterprise and "go" enough to guard against it. Whether the fair be in all respects what might be desired or not, it is tolerably certain to be in the broad sense a success, and reflect great honor on the city, as well as give to it great profit. Chicago now would pay no man much to insure it a population of 2,000,000 in 1900, and counts not a little on the fair to hasten the day which is already in sight, from its point of view, when it will be the leading city of the continent.

The Second Expert Report on the Brooklyn Bridge.

Two Boards of Experts have now "sat upon" the troublesome case of the Brooklyn Bridge terminal facilities. One reported one way; one the other. The case now goes on appeal—an appeal which cannot be averted, unless the ruling spirits of the Board of Trustees should learn wisdom in time, which is not to be expected—to the decision of a third Board of Experts, far more competent, far more impartial, than either of the two preceding boards, the staid old schoolmistress EXPERIENCE, from whose decision there is no escape and no appeal, so that she may be justly described as a whole host of experts in herself. Her teachings proverbially come high, but "we must have them," in cases like the present one. She may not be positively infallible, in that she does not surely indicate the best, but she is negatively infallible, in that she never fails to draw correctly the broad line of distinction between black and white, and bad and good.

To the decision of this exalted personage we should with pleasure leave the whole issue in dispute, confident that she would not take nearly as long to render a decision (after the whole case was once fairly before her) as have either of the former Boards of Experts, except for one fact. Her legitimate jurisdiction is confined to questions of opinion or of experience, not to questions of fact or of physical possibility. We need no Board of Experts, and still less a decision on appeal from Experience, to assure us that 2 and 2 cannot make 5, or that two different solids cannot occupy the same space at the same time, and it is to a statement of fact as absurd and as demonstrably impossible as this that the second Board of Experts have committed themselves, in explicit words which do not admit of question or dispute.

This fact and no other, we propose to point out and record at this time, not with either hope or expectation that it will influence the appeal of the Board of Trustees to the tribunal of Experience, but partly as a matter of duty to the public, whose lives and comfort are at stake, and partly to lay the necessary foundation for enjoying hereafter the gentle satisfaction of saying "I told you so," which is the natural right and privilege of every person who has the foresight to lay a proper foundation for it. Three times before we have had occasion to address similar warnings to the afore-

said Board; three times before they have been compelled to heed them, and we have had the aforesaid gentle satisfaction. A fourth warning is not likely to be so promptly heeded. The ruling spirits of the Trustees have now at last obtained what they have never had before, outside indorsement of plans upon which their hearts have been set from the first, and they will heed no outside warnings. But nevertheless we proceed to make record of the errors of fact in the last expert report, for the reasons stated.

The Board of Experts specifies under ten different heads on pages 4 and 5 of its report its "recommendations" for changes in the present system of operating. It also gives in Fig. 1 the plan for the new New York terminal (published in our last issue) which with one or two trifling changes not affecting its substance, is identical with the so-called "Barnes-Martin" or "Martin-Barnes" plan, adopted by the Board of Trustees just after the first Board of Experts reported condemning it. This plan was illustrated and discussed in our issue of April 28, 1888 (Vol. XIX., p. 336), and it will be seen by comparing the two engravings that the two are practically identical. The Board then proceeds to give its "conclusions" as to this plan in the following words:

The Board believes that these plans, if adopted, will meet all the substantial requirements of the case, at the minimum outlay for property consistent with the objects in view. . . . *The headway between trains can be reduced to 45 seconds, increasing the capacity of the railway with four-car trains from 16,000 to 32,000 passengers per hour, or with five-car trains to 40,000.*

If, as is probable, the headway can be made 40 seconds, the capacity for four-car trains will be 36,000, and for five car trains 45,000 per hour, assuming that passengers insist upon crowding the trains to the extent of 100 per car rather than wait.

It is in the italicized sentences that the second Board of Experts has recommended, not simply questionable or hazardous procedures, but physical impossibilities; impossibilities as certain, if not so transparently evident, as if they had recommended with equal gravity that three pints be carried in a quart pot. This is true even of the smallest capacity named by them, 32,000 per hour, and still more of the 36,000, 40,000 and 45,000 which they announce as probable. Their error has arisen, apparently, from the simple fact that *they have neglected to allow time for the movements of the switch engine* over the grade crossing of the tracks, which of a consequence must be occupied by two trains at once for a considerable fraction of each 45 seconds, to allow the stated number of cars per hour to be dispatched.

This error they have been led into, apparently, by placing over-much trust in certain ingenious-looking diagrams prepared and published by Assistant Engineer LEVERICH, of the bridge staff, purporting to demonstrate that the above alleged capacity was at least a physical possibility, because in these diagrams the same unfortunate and fatal omission is made.

If these inconvenient switching engines could be eliminated from the problem, *and* the trains made to interlock with each other with the regularity of cogs in a pair of cog-wheels, something like the lowest capacity mentioned (not the highest) might be a physical possibility. But to do this, some other method of switching the trains would have to be devised, and no such known device exists, while the possibility that there was any such device in the minds of the experts when framing their report is eliminated by the fact that—

(1) No such device exists, as aforesaid.

(2) It is excluded by implication, as not mentioned in the recommended changes.

(3) It is explicitly excluded in the next sentence but one to that just quoted, where it is stated that locomotives only were contemplated for reaching the above capacity, in the following words:

Only *two objectionable features of the present plan remain if these suggestions are carried out:* The curve near the Brooklyn terminus, *and the use of engines in the building and over the streets of New York.*

If the movements of trains at the terminals be gone over, *including the movements of the switch engine*, it will be readily found that the ultimate limit of capacity with 4 car trains is about 250 cars per hour only instead of 320 to 360, a gain of only 90 cars instead of 160 to 200; while an increase to 5-car trains requires the loss of so much more time in switching that the further gain is really trifling. As for the possibility of switching trains by cable, it was tried when the bridge was first opened and proved an utter failure, even on the short trains and comparatively simple single switching system now in use. The costly plant put in for the purpose has since remained unused. To so handle long trains on a double system over a crossing in almost constant use (more than constant if the Board's recommendations were acted on), and with the very short clearance spaces available, is a practical impossibility, besides being expressly declared to be not a feature of the present plans.

We therefore record our opinion that the proposed plans, if carried out, never can be and never will be forced to carry more than 25,000 per hour, even for a single hour, the available traffic last year being moderately estimated at 21,000 per hour. If so, where does the relief come in? Especially when it is considered that even this increase under the proposed plans involves added chances of break-down and accident of grave moment, which we outlined briefly in our issue of April 28, 1888, it is the safest of prophecies, in our judgment, that the new plans, if carried out, will bring no relief to the traffic which will exist when they are ready for operation, while they will bring with them new evils of their own which, in our judgment, will result in their almost immediate collapse as a working plan.

Were we to go beyond the record of the limitations of fact, into that of opinion and experience, the reasons for this opinion would seem still clearer. For instance, the tremendous jumps in logic by which the Board of Experts essays to explain why short trains are best for handling large traffic, need only to be pointed out to be seen, it would appear to us; but of what use to argue questions of wisdom or propriety if proposals to accomplish physical impossibilities can pass unchallenged? We content ourselves with pointing out the latter.

CORRESPONDENCE.

The Brooklyn Bridge Experts' Report.

BROOKLYN, N. Y., Jan. 21, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: In the report of the second Board of Experts to the trustees of the Brooklyn Bridge, published in your last issue on the subject of increasing the capacity of the latter structure, which has been under advisement by them for some months past, I see it stated that the present traffic of the bridge may be taken as 16,000 passengers per hour—in one direction—or 40 trains of 4 cars, each of 100 passengers per car, the headway between trains being 90 seconds. Quoting from the report: "To increase this capacity it is necessary either to reduce the headway or to increase the number of cars per train. *To what point either of these two things is practicable can be determined only by trial and experience.*"

After stating briefly their examination of the plans presented, the experts go on to say that "they unanimously concluded that the relief *must be sought* rather in the increase of the number of trains (that is, by the reduction of headway), than in the number of cars per train."

What becomes of their opinion previously stated? And on what "trial and experience" is the opinion founded, that the decision of the previous Board of Experts, called in 1888 to consider this very question, must be set aside, and the present method of tail switching, with all the possibilities which it faces, should be recommended? Is this decision based upon any facts not known to or considered by the previous Board, but which have come to the knowledge of the present Board, adverse to the feasibility or safety of the longer trains as proposed, or is it that the tail switching method still leaves the way open to the extension to the Brooklyn City Hall?

The Board of Experts state two methods of increasing the capacity of the bridge to its maximum, differing but little probably in point of expense; the long trains recommended previously in 1888, and the shorter headway advocated by them as applicable to the present four-car trains. Here we see six engineers, presumably equally qualified to form a correct opinion in the premises, who, with the same light before them, are equally divided, it would seem, in their opinions, as to the efficiency and *safety* of two distinct methods of meeting the present difficulty. The Bridge Trustees, for their own purposes, may elect between the two opinions as suits themselves, but there is something more than this that their decision apparently carries with it, and which, it is no disparagement to the individual Trustees to say, they are totally disqualified to determine, and that is, which decision of two Boards of Engineers shall serve as a precedent in the determination of similar problems likely to arise in future improvements on our coast lines, and wide estuary communications. Common courtesy would call for a similar publicity being given by the Trustees to the documents embraced in the present case as was given to the plans accompanying the previous report of 1888, that professional men may decide this question for themselves, and on its merits.

JULIUS W. ADAMS.

[As we have noted elsewhere, a third and unquestionably competent expert, generally known as Experience, is about to render a decision on these contested points. She is not apt to be very long in reaching a conclusion, when there is really a preponderance of truth on one side or other, nor is she apt to quibble or equivocate in rendering her decisions. We may all await her decision in this case with equanimity, confident that whatever is really bad will be unsparingly condemned.—ED. ENG. NEWS.]

The Flush Tanks in San Diego.

NEWPORT, R. I., Jan. 17, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: Referring to Mr. JAS. D. SCHUYLER'S communication upon San Diego sewerage, and especially to so much of the same as relates to the flush tanks in that city, I beg to say that these tanks are of exactly the same pattern as those used since 1885 in the city of Pawtucket, R. I. I have before me the yearly reports from 1885 to 1889 inclusive, of the Sewer Commissioners and City Engineer, of Pawtucket. I extract the following concerning flush tanks used in that city:

1885, 13 tanks in use.—"These 13 tanks, without exception, have worked perfectly since they were started, up to the present time, and we can see no reason why they should not continue in perfect operation. . . . We have yet to find the first tank inoperative."

1886, 17 tanks in use.—"The automatic flush tanks still continue to give perfect satisfaction. . . . We have yet to find the first tank out of order."

1887, 22 tanks in use.—"These tanks continue to work perfectly. Some have been in continuous operation for over three years. They have cost nothing for repairs, and they have keep the sewers to which they were attached in perfectly clean condition."

1888, 24 tanks in use.—"After three years use we still report no expense for repairs, none inoperative, all working perfectly."

1889, 34 tanks in use.—"The tanks in use continue to work perfectly; they keep the sewers to which they are attached clean, and they have cost nothing for repairs."

The foregoing is in accordance with all of the reports that I have received of the working of these tanks, since the improvement made in 1884.

GEO. E. WARING, JR.

The Hemet Valley Dam, California.

A masonry dam is being built in Hemet Valley, 20 miles east of San Jacinto and about 100 miles from San Diego, Cal. It is located at an elevation of 4,200 ft. above sea-level, and will be used in storing water for irrigating the San Jacinto valley. The storage capacity is 6,000 millons of gallons, and the water will be released from the dam and controlled again in the cañon 10 miles below, and conveyed to points of utilization by pipes and asphalt-lined ditches.

The dam will be 150 ft. high, and 90 ft. base. The site for the dam is remarkably favorable. The cañon is only 50 ft. wide at the bottom, and 100 ft. wide at a height of 80 ft., and 200 ft. wide at 120 ft. high. The quarry for the stone is so situated that material can be taken to the dam by wire rope conveyors. A single rope is used as preferable to the double system.

Work was commenced several months ago, and the labor of stripping the foundations is nearly completed, commodious buildings have been erected for the workmen, and the machinery is on the ground. It was hard work getting the machinery up the steep mountain road, so crooked that when a 12-mule team was hauling up the main hoisting engine the leaders were at times pulling in the opposite di-

rection to that in which the load was going, while the intermediate mules were outside the chain, pulling at right angles to it. Cement costs $4 per barrel at the dam.

This dam is being built by the Lake Hemet Water Co., made up chiefly of wealthy residents of San Francisco, who own nine-tenths of the stock, and about 10,000 acres of choice orange and lemon land. Mr. E. L. MAYBERRY, the manager, is one of the largest stockholders. He gives the work his personal supervision, and has devised some ingenious appliances for carrying on the work. The engineer is Mr. JAMES D. SCHUYLER, of San Diego, Cal.

Report on the Chicago Drainage System.

Under date of Jan. 10, 1891, Mr. WILLIAM E. WORTHEN, the new Chief Engineer of the Chicago Drainage Commission, submitted a preliminary report, showing certain feasible routes for the proposed drainage channel from Chicago to Joliet. The substance of this report is as follows:

Mr. WORTHEN first quoted the law creating sanitary districts, and the fact that the act provides that the drainage channel shall have a size and capacity sufficient to produce and maintain at all times a continuous flow of not less than 300,000 cu. ft. of water per minute in a depth of not less than 14 ft., and with a current not exceeding 3 miles per hour. In rocky portions of the channel, where a depth of 18 ft. is attainable, the flowing capacity above given is to be doubled and the channel to be made not less than 160 ft. wide at the bottom.

Of all the new routes surveyed he has selected only two for comparison, and recommends the "Ogden ditch line" as the better one, as being less expensive and as providing for carrying off the storm water of the upper Desplaines River without the necessity of making cut-offs from this river to the lake. In this view the channels estimated and designed for the maximum flow of 600,000 cu. ft. per minute will suffice, and with a gate cut-off in the Ogden ditch line will prevent high water from the Desplaines from flowing into the Chicago River.

The estimated total cost of the entire route of 18 ft. waterway, by the Ogden ditch line, is $25,7.0,000. If the excavation in earth be reduced to 14 ft. and the rubble side walls be omitted, the estimated cost is reduced to $22,700,000. But the difference between the 18 and 14 ft. depth could be more cheaply taken out in the dry ditch than by dredging later. Between Bridgeport and Willow Springs the estimated excavation is 17,526,000 cu. yds. for a depth of 18 ft. of water, and 14,656,000 cu. yds. for only 14 ft. Between Willow Springs and Joliet basin there would have to be removed 3,500,000 cu. yds. of earth and 13,351,830 cu. yds. of rock. Between these points there would be 18,948,600 cu. yds. of waste material, including all the rock mentioned above. The channel proposed would have an average width of 180 ft., with nearly vertical sides and a depth of 18 ft. below the flow line of the water.

Mr. WORTHEN says a route following the line of the canal in Chicago is feasible, but it must be considered that this canal is already a part of a drainage system, and cannot, at present, be dispensed with. Any attempt to convert it into a main channel of the new system, while thus used, would be attended with great cost and difficulty. The report calls attention to the eventual necessity of straightening, widening and dredging the Chicago River and its branches, and of increasing the discharge of the pumps at Fullerton Ave. from the present flow of 12,000 cu. ft. to at least 30,000 cu. ft. per minute. Provisions must also be made for conveying a supply of fresh water into the east and west arms of the South Fork and for carrying off the diluted contents. Attention is called to the fact that while the law provides for a new drainage channel terminating at the upper basin in Joliet, some adequate means must be devised to dispose of the discharge at that place, so that property, health and persons in the Illinois River valley shall not be endangered. To effect the drainage of the whole work during construction the lower portion, toward Joliet, would naturally be first undertaken.

This report is signed by Mr. WILLIAM E. WORTHEN as Chief Engineer and Gen. JOHN NEWTON as Consulting Engineer. As the report is radical in its departure from plans previously proposed, it caused a considerable wrangle between the opposing factions in the Board of Trustees. The late Chief Engineer, Mr. L. E. COOLEY, stated, in an interview published in the *Daily Inter-Ocean*, that data had not yet been secured to determine the cheapest and best location, and he particularly objected to the route suggested, as being longer, in worse material and less useful than others that could be selected. Mr. COOLEY claimed that the flood problem is very inadequately treated, and that the estimates are without detail and incomplete, etc.

Bridge Details, Chicago, Kansas City & Texas R. R.

(WITH INSET.)

The inset published this week shows general details for connections for bridges designed for the Chicago, Kansas City & Texas R. R. Co. by FRANK D. MOORE, of Kansas City, Chief Engineer of the bridge department. The plan selected for illustration is a 136-ft. span, now being built at Smithville, Mo., by the Keystone Bridge Co., of Pittsburg, Pa.

The aim of the designer has been to so shape the connections as to command a minimum pound price, to adapt them to manufacture with common shop tools and to avoid forging and expensive and troublesome shop work. The design is believed to be clear of any ambiguity in the division of strains, and is applicable to spans of any length. Mr. MOORE says that when this design is applied to polygonal top chords the ends of the top strut angles with their connection plates are distorted (bent) cold to match the angle of chords. These top chord angles should always be small; obtuse angles in polygonal top chords, forming shallow trusses at end panels, are in bad practice as giving strains in the design that cannot be properly cared for.

The lower lateral connections are on a plane with the centers of the lower chord pins, relieving the posts from the bending strains otherwise produced by connections out of this plane. This detail is thus applicable to a "suspended" design, without stay rods, and makes a perfectly rigid connection for all laterals, as it brings the floor beam connections above the pins where absolutely rigid union can be secured. The "stiffeners" on the floor beams are "staggered" right and left, in the shop work, to allow the stringers to be swung in clear, after the beams are in place. These stringers have riveted connections between the floor beams, and these rivets are not driven until the span has been "swung," so as to insure them against any tensile strain from the chords, and to obtain as a result a rigid floor system without undue strains. The cross ties used in this case are white pine, 12 ins. deep, with the purpose of forming a cushion and preventing impact. They are spaced close, only 4 to 5 ins. apart, to prevent the soft wood from crushing.

In addition to the dust curtains shown on the expansion roller shoes, there will be galvanized iron aprons on the friction joints of the roller shoes, put on with tap bolts. These aprons are intended to shed water and are shown on the elevation.

Owing to the generally unsatisfactory shop practice in the manufacture of forked heads, the designer shows a connection for loop eyes, in top laterals, with an alternative detail for the top lateral connection with a forked head.

Angles are used for lower laterals on account of the trouble in getting at them for adjustment and the liability of rods to get out of adjustment. The top lateral rod connections are confined to the ends of the struts only, making no extra work on the chords, as the lateral pins do not enter the chord plates. The top end strut web runs down and connects with the portal brackets in such a manner as to be elastic in the direction of the hinge joint at the head of the end post, and is rigid in the direction of wind strain action. This is believed to be a new feature.

The floor beams are all alike, as the usual change in length to accommodate lateral connections on lower chord pins is not required in this detail. The lower flanges of the beams, and their rivet holes are all similar, and all lateral angles for this span are of the same length and punched alike. The only variation is in the spacing from the end rivet holes in the lower flange of the floor beam to the line of the rivet holes in the inner edge of latteral connection plate.

These bridges are to be built of steel, excepting only the counter and top lateral rods. The general specifications, with chemical composition and physical requirements of the steel, are given on the detail sheet.

These details are believed to have been carefully worked out, and the result is a very compact structure. It will be noticed that filling rings are not required on the pins, as the members pack the pins throughout. The lower end chords are latticed to properly transmit wind strains. The end post brace is intended to stiffen the end post in case of a derailed train striking it.

The Kupferle Hydrant.

A new style sidewalk hydrant, claimed to be frost proof, and especially easy to repair, is illustrated in the accompanying engravings. The hydrant is opened by turning the hand wheel at the top. This lifts the plunger and at the same time closes the waste vent marked by an arrow in Fig. 2. The water flows around the side passage and up through the tubular rod which lifts the valve. When the plunger is dropped down to shut off the flow, the waste vent opens and drains the hydrant. The outer case of the hydrant protects the inner pipe from frost. In case it is desired to repair the valve the hydrant need not be dug up, but the bolts in the top cap are removed, the nozzle is unscrewed, and the inner pipe and plunger can be withdrawn. No packing is used in the top of the hydrant, and water cannot come in contact with the operating mechanism at the top.

Fig. 1.—The Kupferle Hydrant.

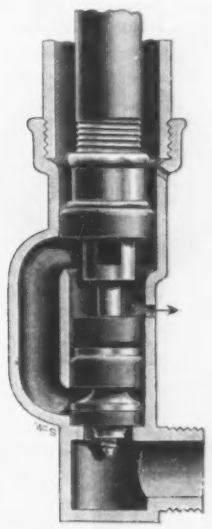


Fig. 2.—Valve and Plunger of the Kupferle Hydrant.

A sand cup to prevent stoppage of the drainage vent is furnished with the hydrant. One criticism which may be made of this device for heavy pressure, is that a small amount of water would be apt to leak past the plunger and enter the frost-proof case, where it would make trouble by freezing. This could be obviated by boring a small vent at the base of the frost case. This hydrant has been placed on the market by JNO. C. KUPFERLE, of St. Louis.

The Census Statistics of Anthracite Production.

Statistics of anthracite coal production for the year 1889 are given in census bulletin No. 20, prepared by special agent JOHN H. JONES. The total production of anthracite during the calendar year was 40,665,152 tons of 2,240 lbs. (equal to 45,544,970 tons of 2,000 lbs.), valued at the mines at $65,718,165, or an average of $1.61⅝ per long ton, including all sizes sent to market. The quantity reported by the transportation companies, as actually carried to

market (the usual basis of coal production statistics) was 35,407,710 tons. The remainder of the coal was used for steam and heating purposes about the mines, or sold to local dealers in the vicinity of the mines. The average number of days worked by each colliery was 191. The chief reason for the suspension of mining during periods aggregating nearly one-third of the year was the inability of the market to absorb a larger product. The total number of persons employed at the collieries was 125,229. The total wages paid amounted to $39,152,124.

Comparing the above figures with those of the tenth census (which, however, were for the period from June 30, 1879, to June 30, 1880), we have the following:

	1880.	1890.
Total production exclusive of culm (long tons)	25,575,875	40,665,152
Equal to (short tons)	28,640,819	45,544,970
Value of product at mines	$42,172,942	$65,718,165
Average price of all grades per long ton at mines	$1.68	$1.61⅝
Total shipments (long tons)	24,566,822	35,407,710
Total number of employees, all grades	70,609	125,229
Total amount of wages paid	$22,664,055	$39,152,124

The year 1888 witnessed the largest annual shipment in the history of the trade, being 38,145,178 long tons.

Of the coal shipped in 1889, Pennsylvania, New York and New Jersey consumed 63.02%; New England took 15.27%; the West took 13.9%; the South, 4.56%, and Canada, 3%.

The enormous growth of the traffic within the past decade as compared with that of early years is shown in the following table:

Shipments of anthracite in long tons.	
From 1820 to 1859 inclusive	83,835,841
" 1860 to 1869 "	107,092,918
" 1870 to 1879 "	195,714,376
" 1880 to 1889 "	315,523,013

Two Improvements in Signaling Devices.

The Hall system of electric signals, described in our issues of Sept. 13 and Sept. 20, 1890, has heretofore differed from the signals generally used in the best practice in that the signal has been of the disk type instead of the semaphore type. As the semaphore signal has been so generally adopted as the standard type on the leading railways, the Hall Signal Co. have designed a semaphore signal for use with their system. In its mechanical construction and principles of operation the Hall semaphore signal differs little from the disk signal, illustrated and described in our issue of Sept. 13. A front view is shown in Fig. 1. The signal and its mechanism are enclosed in a case with glass front and back, as in the disk type.

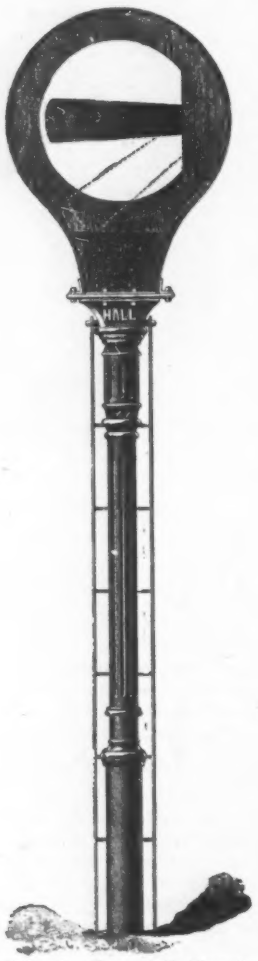


FIG. 1.—The Hall Electric Semaphore Signal.

The semaphore is made of red silk stretched over an aluminum frame, and a counterweight raises it to the horizontal or danger position whenever the electric current by which the signal is controlled is interrupted. The safety signal can only be given by closing the circuit, which forces down the signal to the position shown by the dotted lines. The instrument used is the same that is used for the disk signal, which was illustrated and described in our issue of Sept. 13. It will be seen from the above that the signal can only move to the safety position by the passage of an electric current through the circuit. Any breaking or weakening of the current, or any derangement of the mechanism leaves gravity free to act on the counterweight and draw down the signal to the safety position. To guard against the remote possibility of a broken glass, allowing the semaphore blade to be wet by a storm, the counterweight is made heavy enough to lift the blade when saturated with water, and besides this 50% is added to the weight to make action certain.

The front glass of the case is transparent. The rear glass is translucent, except for a small circular area at the center, which at night admits the light from a lamp with parabolic reflector at the rear. In the daytime the red blade is distinct as could be wished against the ground glass background. In the night the light shines through the thin red silk of the blade at the danger position, and is considerably colored thereby. At the safety position the light shines clear and white through the clear space in the rear glass and the position of the semaphore, inclined across the lower part of the case, is also quite distinct. Thus at night, when signals are hardest to distinguish, the signal indicates both by color and position.

FIG. 4. Indicator Box for Stewart-Hall Train Order Signal.

The Hall signals are now in operation on the New York, New Haven & Hartford, Boston & Albany, New York Central & Hudson River, Michigan Central, Central Railroad of New Jersey, Long Island, and Housatonic railways. The company is now constructing signals for the Central New England & Western, the Erie & Wyoming Valley, the Lehigh Valley, the West Jersey, the Intercolonial and the Central Vermont.

Another new device just brought out by the Hall Signal Co. is a train order signal, the joint invention of Mr. ROBERT STEWART, Superintendent of Telegraphs of the Central Railroad of New Jersey, and Mr. WM. A. HALL. By this device the use of the ordinary flag or lantern for signaling trains, which, for through trains especially, is a most crude and unsafe plan, is done away with. Two of the regular Hall signals, either of the semaphore type, as shown in Fig. 1, or of the disk type, now in common use, are erected beside the tracks, one governing eastbound trains, the other the westbound.

The electric circuit which controls these signals is carried through the telegraph operator's office,

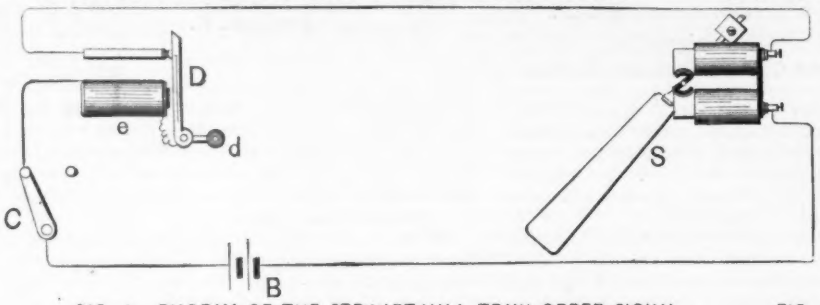


FIG. 2.—DIAGRAM OF THE STEWART-HALL TRAIN ORDER SIGNAL.

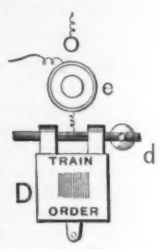


FIG. 3.—DIAGRAM OF INDICATOR BOX.

passing through a switch on the table and what might appropriately be called a "memory box" on the wall of the room. When the operator receives a train order for, let us say, an eastbound train, he opens the switch *C*, Fig. 2, and the circuit being broken, the semaphore in the signal *S* rises to the danger position. At the same time the breaking of the circuit releases a weighted shutter on the front of the indicator box, and it falls down into view, displaying the words "TRAIN ORDER," as shown in Fig. 4. The operator, who, at most stations, is a "general utility" man, may then go about his other business without charging his mind with the train order he has to deliver. He cannot move his signal to safety in a moment of hurry or forgetfulness, and allow a train to pass without delivering the order; but before he can put the signal at safety he must close the switch *C* and then rise from his chair, walk to the indicator box, and, with the words "TRAIN ORDER" before him, press the stop which lifts the shutter, thus closing the circuit and bringing the signal to safety.

Of the advantages of a fixed signal, moved from the operator's table, there can be no question. By it a train may be stopped which otherwise would dash past the station before the operator could get outside to display a flag or lantern. It sometimes happens on double track roads, too, that the track next the station is obstructed by a passing freight train, preventing the operator from signaling a train on the other track. The addition of the indicator box lifts quite a weight from the operator's memory, as well as a load of anxiety from the train dispatcher's shoulders. By requiring his operators to reply "signal displayed" in response to a train order, a train dispatcher may be sure that the train will be stopped and the order delivered.

An important point of merit in the device is that it must be used every time. If it were optional with the operator whether he would display the "trains order" shutter to jog his memory every time he stopped a train, he would be pretty sure to consider it an affront to his mental powers, and would use the box seldom or never. But unless he tampers with the instruments, which he would hardly venture to do, the "train order" shutter will fall every time he puts the signal to danger; and he can put the signal at safety only by closing the switch *C*, and then walking to the indicator box and pressing the button which raises the "train order" shutter. *Vice versa*, the "train order" shutter will not stay up unless he first closes the switch.

The mechanism of the apparatus is very simple. The movable shutter which displays the words "train order" is held up in its concealed position by an electro-magnet when the circuit is closed and the signal is at safety; and when it falls to the displayed position on the breaking of the circuit it makes a second break in the circuit 3 ins. in length.

One of these signals is now in operation at the Somerville station of the Central Railroad of New Jersey, and a party of about 20, comprising the superintendents and signal engineers of some of the

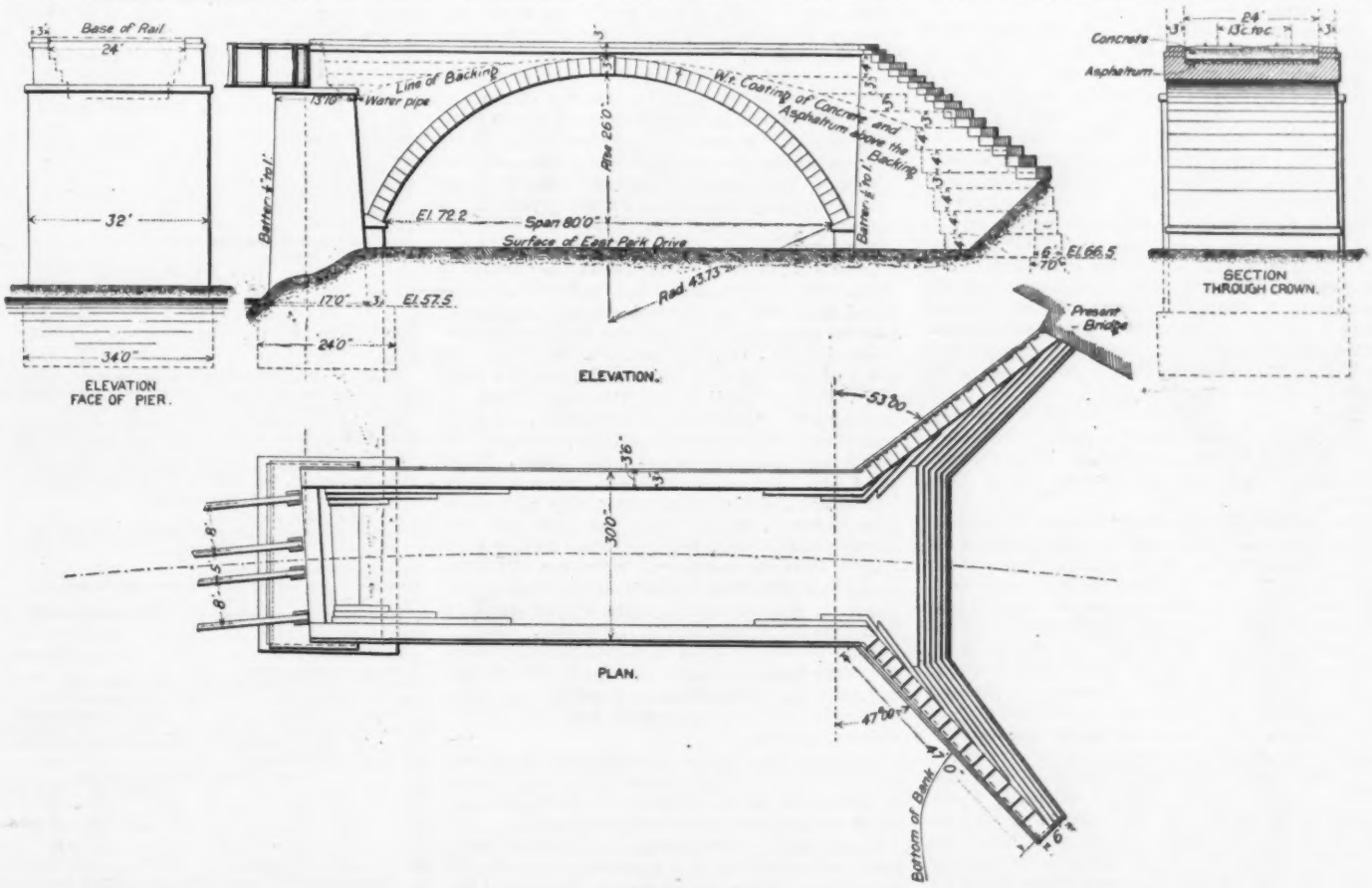
BRIDGE AT FALLS OF SCHUYLKILL, IN FAIRMOUNT PARK, PHILADELPHIA, ON PHILADELPHIA & READING R. R. H. K. Nichols, Chief Engineer.

principal railways centering at New York City, enjoyed a pleasant excursion to that place to witness the working of the signal on Thursday, Jan. 15.

Stone Arch at Falls of Schuylkill; Philadelphia & Reading R. R.

The engravings herewith presented show a neat stone arch of 80 ft. span and a plate girder bridge, built last season at Falls of Schuylkill, in Fairmount Park, Philadelphia, Pa., by the Philadelphia & Reading R. R. The line of railway which crosses the bridge joins the main line at West Falls station, near the west bank of the river, and meets the Norristown division and the lines to the Port Richmond and the Ninth and Green Street terminals a short distance to the east.

The stone arch carries the railway over the Park driveway along the east bank of the Schuylkill River. In the design of the structure it was intended to make it as little out of harmony with its surroundings as possible. A follower of RUSKIN might not admit that any harmony was possible between a railroad bridge and a natural landscape, especially if the bridge were of any material other than stone; but certainly the structure illustrated is as inconspicuous as possible, so far as the river spans are concerned, and the plain, well proportioned stone arch rather adds to the beauty of the landscape. The layer of concrete and asphaltum to prevent percolation of water through the arch is an excellent feature, preventing the dripping on the passers underneath, which is sometimes such a nuisance.



PLAN AND ELEVATION OF STONE ARCH AT FALLS OF SCHUYLKILL; PHILADELPHIA & READING R. R.

The Water-Works at Gouverneur, N. Y.

Gouverneur, N. Y., is a village of 3,500 inhabitants, situated on both sides of the Oswegatchie River, which has its source in the "big woods." A limited water supply was introduced in 1867 by the Gouverneur Water-Works Co. Water was pumped directly from the river through about a half mile of 6-in. cement pipe. Afterward 4-in. cast-iron pipe was laid in several streets and a small amount of wooden pipe, so that at the beginning of 1890 about four miles of pipe had been laid, while 24 hydrants of various kinds were then in use. For some years the pumping has been done by three Green rotary water-power pumps, giving a pressure of from 15 to 35 lbs. The company's intake was below the Main St. bridge and the cemetery. During these 23 years it is stated that but one dividend was declared, all the other surplus earnings having been invested in extensions. The cost of the works to that time had been about $40,000, of which some $20,000, or more, had been met by surplus earnings.

In 1890 the village voted to construct works. It appointed F. S. PECKE, C. E., Watertown, N. Y., as engineer, and on Aug. 8 awarded the contract for new works to L. J. RICHARDSON, Cortland, N. Y., formerly Superintendent of the water-works at that place. The works were accepted by the Board of Water Commissioners Jan. 2, 1891. The village purchased the 4-in. cast-iron pipe of the water company, 2.16 miles, under an appraisal which placed the price at the same figure as paid the contractor for the same pipe, laid. The cement and wood pipe were abandoned, together with 12 of the old hydrants.

The supply is pumped from the Oswegatchie River to a stand-pipe. It is taken at a point above the location of the old intake, and much better water is secured. The suction, or intake pipe, is of 12-in. spiral weld steel, with flange joints, 283 ft. long, 100 ft. being laid from the building to the shore, from which point its course changes and extends upstream into 17 ft. of water, and terminates in a flanged cast-iron cross, with three elbows attached, on the upper flanges of which are bolted brass wire screens with an iron retaining ring. When the pipe was laid there was about 4 ins. of ice over the stream. The pipe was rolled into position upon the ice, the castings bolted on the outer end, and at the shore angle of the pipe a winch was placed, and the pipe suspended from it so as to hang just clear of the ground. Fifteen feet back from the angle was a check valve, and to prevent a torsional strain on any joint a rust joint next the check valve was cut out, permitting the pipe to turn in the flange. In order to have the pipe under control while sinking, it was necessary to devise a simple means to prevent a too rapid flow of water into the river end of the suction, through the screens. This was accomplished by making a plastic mass of fire clay, and applying it to the surface of the wire screens, where it was frozen solid in a few moments. The ice was then cut on both sides of the pipe from the shore outward. A line was passed under the end of the pipe at the castings, and made fast at one end to a boom, and at the other end was slipped

around a tree, to be slacked off as the pipe went to the bottom.

The buoyancy of the steel pipe was so great that it was the only delaying portion of the work after the ice was all cut, to sink the end far enough to admit water. Water was poured in through a hole cut out of the frozen fire clay, until the pipe at the end was submerged, when the whole line settled evenly into place. The entire process of sinking the pipe, after the ice was cut, did not consume 15 minutes.

In this connection it may be well to describe the river crossings, of which there are two, both of spiral weld steel, one 8 ins. in diameter and 300 ft. long (317 ft. of this kind of pipe), laid on the river bottom, in 16 ft. of water, one 6 ins. in diameter and about 235 ft. long, suspended from the Main St. bridge.

The 8-in. crossing had three ball joints, one at the foot of each river slope, and one in the middle of the river. The pipe was bolted together on the shore, and pushed out into the river as fast as necessary, the outer end being plugged.

When the entire line was put together and drawn into place, a raft was placed on each side of each ball joint, and each such pair of rafts secured together and a rope passed around the pipe, both ends being wound on a winch on the raft. The same process was also adopted for the center of the spaces between the ball joints, whose tendency was to sink while the remainder of the pipe floated.

The rafts and lines being all in place, water was poured into one end of the pipe, until there was just enough to sink it, when each raft lowered its line, as ordered by the engineer, who occupied a boat in the center of the river.

The amounts lowered by each raft respectively were in accordance with the profile of the bottom, and at the last order given each raft reported lines slack and the pipe on the bottom, except a short distance on the west side, where there was a deep hole which is spanned by the pipe.

The 6-in. line on the bridge is flanged and connects at one end with a line of 6-in. wrought iron pipe spanning a race-way. It is hung from the floor-beams of the bridge with adjustable bolts.

The pump-house consists of a wooden frame, covered with corrugated iron, with foundations of native marble, 2 ft. thick, with a footing course 4 ft. wide and 2 ft. deep, in Rosendale cement. The latter are laid, mostly, on a double plank platform 4 ft. wide, resting on quicksand. The engine room is 26 × 28 ft. × 14 ft. high. The boiler room is 28 × 40 ft. paved with sawed marble slabs.

The pumping machinery consists of two compound, duplex non-condensing pumps, with 12-in. h.p. cylinders, 18½-in. l.p. cylinders, 11-in. plungers and 18-in. stroke. The feed pump is a 6 × 4 × 6-in. duplex.

The feed pump has an independent 2-in. suction pipe to the river, and also a suction connection with the main, so that it may be primed from the main, or take its supply from the main or the river at will. The feed pipe and connections are so arranged that the boilers may be fed by the pump either with hot or cold water, or may be fed from the main pressure, either through the heater or cold. The feed water, in any case, passes through a Crown meter, located on the delivery near the pump.

The steam cylinders of the main engines are lagged with Russia iron, and valves are so placed as to permit of a cross exhaust, and also the admission of live steam to the low pressure cylinders. Water glasses are placed on the air chamber of both engines, and vacuum gages on the suction vacuum chambers of both. There are six figure counters on each engine and Detroit sight feed lubricators on all pumps. The cylinder cocks and drip pipes are all led to the front of the pump and carried down through the floor in line, with the valves in symmetrical rows. These pipes empty into a 2-in. pipe, which in turn is connected with the 6-in. waste pipe from the heater. The exhaust from each pump is connected with a heater with a 4-in. pipe, and also runs through the roof to the outer air, with suitable valves on each. The heater is a No. 4 Erie City (Pa.) heater, with 27 2-in. tubes. The pumps are made by the Deane Steam Pump Co., of Holyoke, Mass. They pump easily 800 galls. per minute against 80 lbs. pressure, with 80 lbs. of steam, and are running daily against a pressure of 100 lbs. when the stand-pipe is full. The foundations of the main pumping engines were built on solid clay, which was found some distance below the foot of the building walls east and west. The ground on top was quicksand, and being on a side hill, and limited as to room, it was impracticable to get to clay bottom on the north side.

The boilers, two in number, were built by the Phoenix Foundry & Machine Co., of Syracuse, N. Y. They are 60 ins. in diameter, and 14 ft. long, with full flush cast-iron fronts. They passed a very satisfactory test, carrying steam pressure of 120 lbs. without discovery of any defect other than a single rivet which leaked when the boiler was first fired. Connection between the two boilers is made with 4-in. pipe, and valves so arranged that either pump may be run from either or both boilers, or each pump with its own boiler. Edson recording gages are set in the engine room, for both water and steam, and a water gage also, of the ordinary type.

The force main is a 10-in. spiral weld steam pipe, 2,700 ft. in length, with flange joints. The pipe was laid in a trench excavated in solid rock 7 to 8 ft. in depth for a distance of 30 ft. In the entire construction there was estimated to be 1,200 cu. yds. of rock excavation, and the actual amount was short of this by 158 cu. yds. The soil was in some places dry and fine sand, and in others it was filled with water to within 2 ft. of the surface, making it difficult to keep the trench from filling up as fast as it was excavated. Clay was encountered in several places.

The standpipe is 30 ft. in diameter and 40 ft. in height with a bottom of ⅝-in. steel. Two rings or courses of 4 ft. each of $\frac{5}{16}$-in., one course each of $\frac{9}{32}$, ¼ and $\frac{7}{32}$-in., respectively, and 5 courses of $\frac{3}{16}$-in., with 4 × 5-in. angles at the bottom, inside and outside, and 3 × 3-in. angles at the top of the last course. It was built by the Porter Manufacturing Co., Syracuse, N. Y.

The foundation is on solid rock, of masonry varying from nothing to 3 ft. in depth. On top of the masonry was swept a coat 2 to 3 ins. thick of rich Portland cement. The arch under the foundation for the entrance of the pipe to the bottom of the tower is of concrete. The pressure from the standpipe is 100 lbs. at the pumps and 90 in the business part of the town.

The works include 3,526 ft. of 10-in., 3,143 of 8-in., 6,870 of 6 in., 10,153 of 4-in. cast-iron pipe; 283 ft. of 12-in., 2,650 of 10-in., 317 of 8-in., and 235 ft. of 6-in. spiral weld steel pipe; total, 5.2 miles, including hydrant branches. This pipe was from the Jackson & Woodin Mfg. Co., Berwick, Pa. With the 2.16 miles of 4-in. cast-iron pipe bought from the company, there are now 7.36 miles in the system, including all pipes above 4 ins. in diameter. In addition there is one mile of 2 to 1½-in. wrought iron pipe for service on streets not having mains. There are 4 6-in. three-way and 49 4-in. two-way Galvin hydrants, all with 2½-in. nozzles; also 12 Ludlow gate hydrants, mostly with one hose and one steamer nozzle each, these hydrants having been bought from the company. There are 41 Galvin valves and 14 Ludlow valves formerly in use by the company. Globe specials, made by the Builder's Iron Foundry, Providence, R. I., are used.

Of the old service pipes in use the majority are of 1-in. black iron, and most of the pipe is so filled with rust that the effective internal diameter is not more than ⅝ ins., while some services have an effective diameter even less.

At present there about 150 consumers, including one railway. The total average daily consumption, or rather the total pumpage, is 200,000 galls., of which about 50,000 is used by the railway.

The test of the works showed but four small leaks in the entire distributing system, or less than one to two miles, including the old mains. The cost of the works including the purchase of a part of the old plant was $100 less than the engineer's estimate.

We are indebted to the engineer of the works, Mr. F. S. PECKE, C. E., for the above data.

Improvement of the Hudson River.

A hearing is in progress at Albany this week before Col. G. L. GILLESPIE, Major C. W. RAYMOND and Major AMOS STICKNEY, of the U. S. Engineer Corps, a commission appointed to investigate the proposed deepening of the Hudson River to Troy and the improvement of its navigation generally. Among the facts and figures presented that have a general interest are these:

Col. GILLESPIE stated that the present approximate depth of the Hudson was 11 ft. from New York to Albany and 9 ft. to Troy. The late action of Congress proposes to largely increase this depth and the width of channel, and the present meeting is held to ascertain the views of those interested before the expression of an opinion by the board as to the usefulness of the work at this time and its relation to commerce. Mr. V. H. YOUNGMAN, of the Albany Chamber of Commerce, advocated the proposed work by stating that it was necessary to secure trade now going to Canada. It was better and less expensive to load ocean vessels at the mouth of the canals than at New York, and this deepening of the channel would practically move the ocean port 150 miles inland. As to the justice of doing this work by Government aid, Mr. YOUNGMAN stated that the total tonnage on the Hudson was 18,500,000 tons per annum; for the betterment of this river the government appropriated $1,516,438. The combined tonnage of the Ohio, Missouri and Mississippi rivers is only two-thirds of the amount given for the Hudson, and for their improvement the sum of $45,999,555 has been appropriated.

Summary of Meteorological Observations at New York City during the Year 1890.

BY L. N. JESUNOFSKY, SERGT. SIGNAL CORPS.

Air Pressure in Inches.

Mean, reduced to 32° F	29.86
Mean, reduced to 32° F and sea level	30.06
Highest, reduced to 32° F and sea level Jan. 1	30.77
Lowest, reduced to 32° F. and sea level Oct. 29	29.35
Annual range	1.42
Mean monthly range	0.87

Mean Hourly Valves.

1 A.M.	30.06	7 A.M.	30.07	1 P.M.	30.04	7 P.M.	30.04
2 "	30.05	8 "	30.07	2 "	30.04	8 "	30.04
3 "	30.05	9 "	30.07	3 "	30.02	9 "	30.06
4 "	30.05	10 "	30.07	4 "	30.02	10 "	30.06
5 "	30.06	11 "	30.07	5 "	30.03	11 "	30.06
6 "	30.06	12 noon.	30.05	6 "	30.03	12m'd't.	30.06

Air Temperatures, Fahrenheit Degrees.

Mean	54
Highest, July 8	95
Lowest, March 7	6
Annual range	89
Greatest daily range, Feb. 7	40
Least daily range, Sept. 14, Aug. 9	4
Greatest monthly range, March	65
Least monthly range, June	34
Mean of absolute monthly range	45
Mean daily range	15

Mean Hourly Values.

1 A. M.	50	7 A. M.	49	1 P. M.	56	7 P. M.	55
2 "	50	8 "	50	2 "	57	8 "	54
3 "	50	9 "	51	3 "	57	9 "	53
4 "	49	10 "	52	4 "	57	10 "	52
5 "	49	11 "	54	5 "	56	11 "	52
6 "	49	12 "	55	6 "	56	12 m'd't.	51

Number of days maximum below 32°: January, two days; February, one day; March, four days; November, one day; December, seven days; total 15 days.

Number of days minimum below 32°: January, 15 days; February, 11 days; March, 15 days; April, three days; November, four days; December, 23 days; total, 71 days.

Number of days maximum above 90°: July, four days. First ice formed, Nov. 21; last ice formed, April 1.

Humidity.

Mean dew point, degrees	43
Mean relative humidity, per centum	73

Cloudiness.

Mean (scale 0 to 10 tenths)	5.4
Greatest mean monthly, February and March	6.8
Least mean monthly, June	5.1

There were 82 cloudless days, 150 partly cloudy days, and 133 cloudy days.

Wind.

Prevailing direction	northwest
Total movement, miles	98,784
Greatest monthly movement, miles, December	11,231
Least monthly movement, miles, September	6,534

Highest velocity from N. W., 55 miles per hour, Jan. 22. Number of times blowing from the N. (2 observations daily), 81; N. E., 72; E., 22; S. E., 90; S. 111; S. W., 106; W., 91; N. W., 154; calm, 0.

Mean Hourly Values (Miles).

1 A. M.	11	7 A. M.	10	1 P. M.	13	7 P. M.	12
2 "	10	8 "	10	2 "	13	8 "	11
3 "	10	9 "	11	3 "	13	9 "	11
4 "	10	10 "	12	4 "	13	10 "	11
5 "	10	11 "	12	5 "	12	11 "	10
6 "	10	12 noon.	13	6 "	12	12 m'd't.	11

Precipitation (From Rain, Snow, Hail and Sleet).

Total ins.	52.30		
January	trace.	April	1.2 in.
February	4.0 in.	November	trace.
March	21.3 in.	December	19.1 in.

The last snow of the season occurred on April 1.

The first snow of the season occurred on Nov. 27.

Greatest monthly precipitation in September	8.21
Least monthly precipitation in November	0.82
Greatest daily precipitation in any consecutive 24 hours, Sept. 16 and 17	5.12
The average annual precipitation at New York City (for the past 20 years)	43.54

For each month, in inches:

Jan.	3.76	April	3.27	July	4.36	Oct.	3.36
Feb.	3.69	May	3.05	August	4.84	Nov.	3.52
March	3.88	June	3.26	Sept.	3.34	Dec.	3.71

There were 144 days on which 0.01 in. or more, of rain or melted snow occurred.

Thunder storms occurred as follows: On March 1; April 3; May 5; June 9; July 3; Aug. 9; Sept. 5; Oct. 1.

The last frost of the season occurred on April 1; the first frost occurred on Oct. 9.

The Reconstructed Woodlawn Crossing.

The accompanying diagram and perspective view illustrates a rather peculiar form of junction arrangement, adopted for the joint purpose of eliminating the grade crossing which is otherwise inevitable at a double track junction, and at the same time reversing the "left hand" running of the New York & Harlem R. R. to the "right hand" running of the New York, New Haven & Harford R. R. The case occurs at the Woodlawn junction of these two roads, 12 miles out from the Grand Central Station, where the Harlem "depressed tracks," or extension of the depressed (or elevated) entrance to the Grand Central Station, may be said to terminate.

This reversal from left hand to right hand running was made necessary by the fact that the local arrangements of the terminus made it obligatory that the outgoing tracks should be at the west or right of the incoming tracks, which for many years has made it necessary that the incoming tracks should cross the outgoing directly in front of the building. In spite of all the aid to be obtained from interlocking this arrangement caused much delay and inconvenience, as might have been expected, until it was finally determined to do away with the crossing altogether by running all trains into the station on the left hand instead of the right hand tracks.

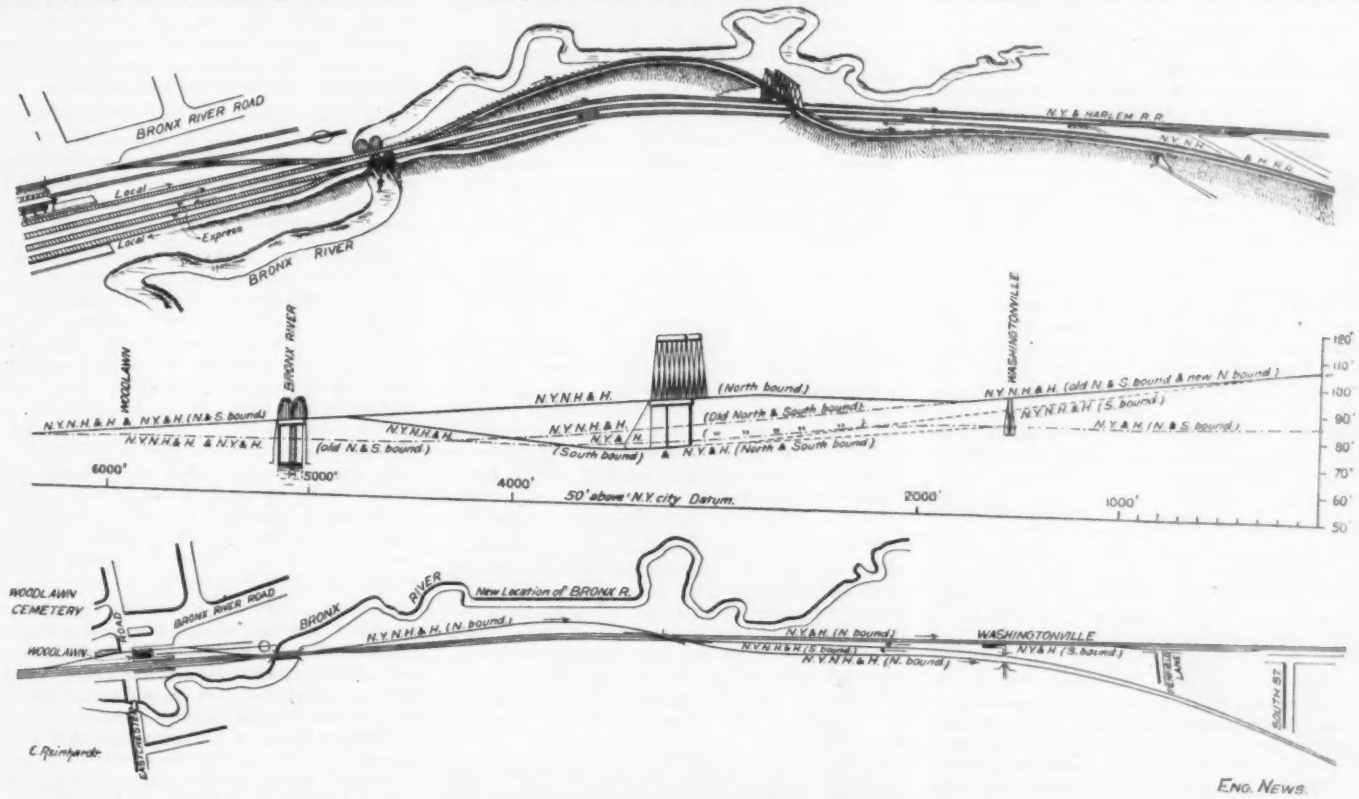
As it was desirable to eliminate the junction grade crossing at Woodlawn anyway, however, it became unnecessary for the New York, New Haven & Harford to reverse the usual American practice of "keeping to the right" with trains as well as road vehicles. The plan illustrated was used instead to reverse the position of the tracks.

It may look at first sight as if a clumsy gauntleting of tracks had been adopted at the bridge over the Bronx River to save the comparatively trifling expense of widening the bridge from a two-track to a four-track roadbed. But this is not the case. There are four tracks above and also four tracks below this bridge; but the four tracks above are for the double tracks of two different railways, while the four tracks below are merely a pair each for the express trains and local trains respectively of both these railways. Consequently, the four tracks above must be run together to two tracks at some point to effect the necessary distribution, and advantage was taken of this fact to save the expense of widening the bridge by running the tracks together over it. Of course all the tracks, switches and signals are protected and operated by an interlocking plant.

In time, the traffic here is likely to become very heavy, as in fact it is now.

It is not generally known that the English "rule of the road" in regard to wheeled vehicles is directly the reverse of the American. All vehicles there "keep to the left," which would seem to be the more sensible rule, since the driver there as here sits on the right side of his vehicle, and by passing to the left he has a better chance to see that he is effecting a proper clearance. But in America, and also throughout the continent of Europe, so far as we have observed, the rule is for the driver to both sit on the right side and keep to the right.

In different parts of the Dominion of Canada both practices prevail. In the Eastern maritime provinces, and in British Columbia, the English rule prevails, but in Quebec, Ontario and Manitoba the American rule. How the English colonists of this country ever came to reverse a practice which would seem so particularly likely to be a matter of tradition and all but unchangeable, and when they did so we do not know. If any of our readers do we shall be pleased to have them inform us.



PERSPECTIVE SKETCH, PROFILE AND PLAN OF TRACK IMPROVEMENTS NEAR WOODLAWN, N. Y., ON THE N. Y., N. H. & H. AND N. Y. & H. RAILROADS. Walter Katte, Chief Engineer.

The Suram Tunnel, on the Trans-Caucasian Railway.

This tunnel, which was officially opened to traffic about one month ago, was built to avoid the heavy grades over the Suram Pass, on the Batoum-Baku line constructed in 1873. The road formerly passed over the Suram Mountain at an elevation of 3,027 ft. above sea level with grades of 4.5 and 4.8%. The distance from Batoum to Baku, or from the Black Sea to the Caspian by this line is 546 miles.

In the original construction of the road these heavy grades were adopted to avoid the expense of the tunnel, otherwise necessary. The old line is one of magnificent scenery, the road following deep and crooked ravines with curves of 700 ft. radius and grades very nearly approaching 5%. As a consequence the traffic over the Suram Pass was limited. Two four-cylinder Fairlie locomotives hauled 14 carriages of about 10 tons each, and the annual capacity of the line is figured at 1,200,000 tons in *Le Genie Civil*, of Dec. 20. The transportation of petroleum products from Baku makes up one-third of the traffic on this line; but much of this lately passed to the Black Sea by way of the Caspian Sea and the Volga and Don, owing to the insufficient capacity of the railway line.

In 1887 work was commenced upon the reconstruction of the road between Mikhailowo and Kwirila, a distance of about 38.5 miles, including in this length the Suram Pass. On this new line the maximum gradient is 2.8% and the minimum curve radius is 918 ft. Under the Suram a tunnel is now driven for a length of 13,000 ft., with a maximum grade of 1.8% toward the Black Sea. The advance heading, finished in November, 1888, was driven by the Beaumont drill on the west side, and by hand from the East. Commencing on the east, the soil penetrated was marl, with a very wet schistose rock, alternating with sandstone; and for a short length toward the west face some limestone and clay. There was much trouble from water.

The tunnel is of horseshoe form and is arranged for double track, of standard gage. The masonry lining varies from an average thickness of 3.5 ft. to 16 ins. as the soil requires. The hydraulic power required for the drills varied in pressure from 38 to 43 atmospheres, and was supplied by a double-cylinder compressor of 70 HP. The so-called Austrian method of attack was used, with a bottom advance heading, the latter being kept with its face about 330 ft. in advance of the full tunnel section.

Progress on the New Railway Terminals at Providence, R. I.

Work has been steadily progressing for nearly one year now on the terminal improvements for the railways centering in Providence, R. I. The extent of work done to date is best made clear by the following abstract from a long and excellent article on this subject contained in the Providence *Sunday Journal* of Jan. 11:

The two railways interested, the New York, Providence & Boston and the Old Colony, have alone spent within the year about $100,000 upon work strictly connected with this improvement, and $250,000 when the new four-track work is included. The city began in August, 1889, the building of the retaining walls that will bound the new channel of the Woonasquatucket River across the old cove. The river channel will be 100 ft. wide, but a much wider space has been dredged to an average depth of 18 ft. below mean high water, and the mud replaced by gravel extending to 8 ft. below high water. On this gravel the side walls have been built for a length of 875 ft. on the north, and 925 ft. on the south side. The old cove is now being filled in behind these walls. The abutments for the railway crossing have been finished by the railway companies. These

abutments will carry the station walls and 12 tracks over a stream 100 ft. wide and a street 74 ft. wide.

The Moshassuck River is also having a new 45 ft. channel prepared for it, and is made to join the Woonsocket by a curve of 265 ft. radius. This work is to be done by the railways and by the city, and on the part of the latter about $2,500 has been spent. The railways have done more work in dredging, building side walls, etc.

The change proposed at Smith St. is well under way; the abutments are commenced, and the bridge across the river will be a through truss and will span six tracks. Work is also commenced on a wall, to be 680 ft. long and about 22 ft. high, which is to extend north of Smith St. bridge and carry State St. At Martin St. an iron bridge is in course of erection by the Boston Bridge Works. The highway crosses the tracks at an angle of 26°, and the abutments are 22 ft. high and 92 ft. long. The bridge is a half-through riveted iron truss, with buckle-plate floor of right angle sections to carry stone ballast. Another bridge at Charles St. will be of the same general character as those described above.

A new interlocking plant is being put in place by the Union Switch & Signal Co. at Dexter St., Pawtucket, the present end of the four track system. This plant, while not large, having 14 working levers, is said to possess features of peculiar interest. The interlocking at the Boston switch is more complicated, having 28 working levers, 10 work switches, 6 facing point locks and 12 signals. There have also been extensive changes in the electric block signals during the year.

The city work on the cove is in charge of the City Engineer, with Mr. WILLIAM D. BULLOCK in immediate charge. The contractor for all the city work is Mr. G. G. NEWMAN. The railway part of the work is in charge of the engineer department of the New York, Providence & Boston R.R., Mr. E. P. DAWLEY, Chief Engineer. The contractors for this portion are, I. T. TANK and INGERSOLL & FOWLER, of Providence; JOSEPH ROSS, of Ipswich, Mass.; the Boston Bridge Works and the Union Switch & Signal Co., of Swissdale, Pa.

THE MOST FATAL RAILWAY ACCIDENT of the week was a locomotive boiler explosion at Gordon, Pa., Jan. 14, on the Philadelphia & Reading R. R., a few miles northwest of Pottsville. The engine was standing on a side track when the boiler gave way. The engineer and two brakemen were killed.—Another locomotive boiler explosion occurred on the Alabama & Vicksburg division of the Queen & Crescent system on Jan. 15. The engine was a mogul switching engine, built by the Baldwin Locomotive Works, and was getting up steam to pull a train up the incline from the car transfer at Vicksburg when the explosion occurred. The engineer and fireman were killed.—Passenger train accidents have been remarkably few and unimportant. The most serious was a head collision on the Long Island R. R. on Jan. 15 near Jamaica between a "rapid transit" train, consisting of a light locomotive and one car, and a freight train. The collision was due to the disregard of block signals by the engineer of the rapid transit locomotive. Several passengers were injured.

THE NEW YORK AQUEDUCT COMMISSIONERS decided on Jan. 22, by a vote of 5 to 2, to build a dam across the Croton River at Cornell's, 1¼ miles above the site of the proposed Quaker Bridge dam, and about 2¾ miles below the present Croton dam. According to an adopted resolution plans for the dam will be made at once, and construction begun as soon as possible. According to the report of Chief Engineer A. FTELEY, made Oct. 8, the dam will form a reservoir with a capacity of 30,000,000,000 galls. It will have an extreme height above the river bed of 159 ft., and extreme depth below that point of 70 ft., or an extreme total height of 229 ft. The total length of the dam between flow lines will be 1,736 ft. The estimated approximate cost of the dam proper is $3,650,000 and of railways, roads, bridges and clearing, $1,075,000, making a total of $4,725,000. The probable time necessary for construction is given as five years, against six for the Quaker Bridge, and four for the "New Croton," if of masonry, or three to four if of earth and masonry, as recommended. An all-masonry section is recommended for the greater part of the length of the dam, but it is stated that a portion of the surface on the south side is favorably situated for the construction of a partial earth embankment. The adopted site will give a total drainage area of 376.3 square miles, or a drainage area of 20.9 square miles, and a storage capacity 14,000,000,000 galls. greater than the "New Croton" dam site, recommended by Engineer FTELEY. The drainage area will be but 1½ square miles, and the storage capacity but 4,000,000,000 galls. less than the proposed Quaker Bridge dam, while the height above and below the river bed will be 21 ft. less for each, or 42 feet less for the total extreme height. The total cost of the dam at the accepted site will be $1,437,000 less than at the Quaker Bridge site, or $4,725,000 against $6,162,000, all of the figures of cost, leaving out the $300,000 estimated cost for the Muscoot dam, which is considered in connection with all the sites. The "New Croton" dam recommended by Engineer FTELEY had an extreme height above the river bed of 105.5 ft, an extreme depth below of 100.5 ft., or a total height of 206 ft. Its total length was 995 ft. between flow lines, and the cost for the dam and accessories $3,350,000 if of masonry, and but $2,660,000 if of earth and masonry, as recommended.

THE DALLES BOAT RAILWAY PLAN, for passing the obstructions in the Columbia River, has failed to pass the House Committee on Rivers and Harbors. The boat railway with its hydraulic lifts was estimated to cost $2,800,000, and $80,000 annually to operate it. The estimate for locks and canals was $3,754,355. The final outcome of the arguments before the committee was the endorsement of a temporary portage railway around the obstructions, to cost $431,500.

NEW SMALL ARMS AND NEW POWDER are to be tested before the board of army officers on magazine guns, now in session in this city, with Gen. AUGUST V. KAUTZ as chairman. This board has already decided upon the Wetteran powder for use in the coming test of small arms. This powder is made in Belgium, is a modified Du Pont powder, and is said to give a pressure of from 50,000 to 55,000 lbs. per sq. in., and a muzzle velocity of 1,800 ft. per second. The test calls for guns of .30 caliber, and it is expected that the trial will commence within the next two weeks at the Springfield (Mass.) Arsenal.

THE CITY & SOUTH LONDON ELECTRIC RAILWAY, lately opened, is experiencing difficulty already from the crush of passengers desiring to use it. This is a grateful bit of trouble to stockholders; but it will necessitate the lengthening of trains and a large increase in power. The company now proposes to extend its line in the city of London to Islington, or two miles further. The capital asked for is $3,300,000, with power to borrow a further sum of $1,100,000.

THE JAPANESE INSTITUTION OF ENGINEERS, says *Industries*, is made up of 11 honorary members, 353 members and nearly 1,000 associate members. The President is Viscount YAMOU YOSO, for many years Acting Minister of Public Works. The honorary members include two foreigners, and the general list is made up of those actively engaged in the many engineering works and manufacturing industries of that country. This is doing well for an institution founded only 10 years ago, by the graduates of the Tokio Engineering College, which was itself started 17 years ago.

STREET CLEANING FIGURES for ST. PAUL, Minn., are thus given by City Engineer RUNDLETT: The work is done by the city. The asphalt streets are swept by hand, each man taking care of 1,000 lin. ft.; but all other streets are swept by machines, and the total swept by machines in 1890, was 2,380.57 miles at an average cost per mile of $9.52. About 9 miles of streets are swept every day; 18.5 miles three times a week and 7 miles three times in two weeks. Garbage is collected by contract, three times per week from residences and daily from hotels and boarding houses. St. Paul has now 41 miles of paved streets. The total area of the city is 55.44 sq. miles. The total cost of street sweeping, in 1890, was $31,636.03, and of collecting garbage, $11,000. The population of St. Paul is about 200,000.

THE MEKARSKI COMPRESSED AIR TRAMWAY SYSTEM has been adopted on a street railway in Berne, Switzerland. There are nearly 4¾ miles of track in this city that have been operated under the Mekarsk patents since October, 1890. The results so far obtained are apparently satisfactory.

PUNCHING TICKETS WHILE THE TRAIN IS IN MOTION, by guards passing along the dangerous outside footboards, has been stopped by an order from the German Minister of Public Works. The tickets must now be punched at the "barriers." The same step has been taken in Norway.

A RACK RAILWAY is to be built between Göschenen and Andermatt, or from the mouth of the St. Gothard tunnel to the famous resort of the latter name. The road would be 2.3 miles long and have two tunnels of about 3,300 ft. each. The maximum grade is 20%, and the minimum radius 656 ft. The estimated cost is $260,000. The concession is granted to M. GRUSSI, a Swiss Engineer; but among the conditions is one stipulating that one of the tunnels must be so bored that one end can be illuminated by an electric light from a neighboring fort.

THE COLORADO STATE ENGINEER'S REPORT for the two years ending Nov. 30, 1890, according to the Denver *Republican*, shows that there are in the State 10,000 miles of irrigation ditches, over 1,000,000 acres of land under irrigation, and 4,000,000 acres under ditch. The report shows 2,188 filings of ditch and 333 of reservoir statements. Irrigation from storage reservoirs is said to be increasing rapidly.

THE NEW CROTON DAM PROJECT was heartily endorsed on Jan. 21 by the New York Board of Trade and Transportation, as was the proposition that the present Aqueduct Commissioners ought not to be dismissed, as proposed in Mayor GRANT'S late message, until their work is completed.

A CAR STARTER, especially adapted for roads with heavy grades and which has the merit of being as simple as most inventions of the class have been complicated and impracticable, has been put in use on all the cars, 32 in number, of the Albany Electric Ry. The device consists merely of a hinged dog attached to the car and backed by a spiral spring. Whenever the car stops on an up-grade the motor man moves a foot lever which drops the dog and then releases the brakes. The car rolls back a foot or so, compressing the spiral spring against which the dog bears. The push of this spring is claimed to aid the car in starting. For electric roads of steep grades, where the principal accidents to stopping gears occur in starting on the grades the device seems to be worth attention.

THE FIRST DRIGGS-SCHROEDER GUN has been finished, tested and accepted by the government, at the Colt's Arms Works, in Hartford, Conn. It is a six-pounder, weighs 848 lbs., has a range of 5 miles and uses a hardened steel projectile that will pierce 6 ins. of steel at a considerable distance. It has the rapidity of fire of a Gatling gun, and is so nicely balanced on its pedestal that a touch of the finger will reverse the breech and muzzle. The mechanism is simple, and a new and ingenious training device enables a vessel or other moving object to be kept under constant fire. The present gun is the joint invention of Lieutenants W. H. DRIGGS and SEATON SCHROEDER, U. S. Navy.

THE NEW NIAGARA BRIDGE, to be built by the Canadian Pacific R. R. Co., according to its letters of incorporation, will be 6,000 ft. long, including approach connections. The new line would start from the river, cross the New York Central overhead and follow the West and South lines of the Erie tracks to Ninth St., Suspension Bridge. The capital stock is $200,000, and the board of direction represents the Canadian Pacific road alone.

THE GERMAN IRON MANUFACTURERS, says a Berlin dispatch to the *New York Herald*, will present to CHAS. KIRCHHOFF, Jr., ROSSITER W. RAYMOND and WILLIAM P. SHINN a silver goblet each, in remembrance of the kindly welcome extended to them on the occasion of their late visit to America. The gentlemen above named were chiefly responsible for the detail of their reception. The goblets will be in the form of Bessemer converters, and are said to be curious and unique.

CAST IRON BRICKS are noted as a late German invention. They are hollow, with very thin shells, and are to be laid without mortar; grooves and corresponding ribs hold them together, assisted by two hook-shaped lugs in each brick. The outside surfaces are to be heavily painted. The advantages claimed are that they are lighter than ordinary brick, make a house cool in summer and warm in winter, and they

readily admit of being taken down and used in other structures without requiring skilled labor.

THE NEW YORK RAPID TRANSIT COMMISSION is now at work receiving plans and suggestions for improvements in rapid transit. Among those presented were the old Broadway Arcade scheme; the People's Rapid Transit Co.'s plan for a lofty masonry viaduct; Mr. LAWSON N. FULLER'S plan for a double decked elevated railroad, and the Greathead Underground Electric Ry. Co.'s plan for a double tunnel road. Other plans and suggestions for plans were submitted, but the above were the most prominent.

THE TWO ALUMINUM MAKING COMPANIES, the Pittsburg Reduction Works and the Cowles Electric Smelting & Aluminum Co., are now at law, the latter company suing the first-named for infringement of patents. The Pittsburg company is confident of its position, and claims this suit will only strengthen its patents. Mr. G. H. CLAPP, of the Pittsburg works, says that the Cowles company makes an alloy only and depends upon the heat produced by electricity; while the Pittsburg company makes pure aluminum and depends upon the action of an electric current. The rumored consolidation of these companies, with a large factory at Niagara, has evidently failed to come to pass.

THE HANNAFORD ELECTRIC LIGHTHOUSE.—U. S. Consul CONNOLLY, of Auckland, furnishes a meager description in the Consular Reports, No. 121, of the Hannaford electric lighthouse, of which a working model is on exhibition in Auckland, New Zealand. Briefly described, Mr. HANNAFORD proposes to use an electric light, and to generate his power by a wind-mill attachment to the top of his lighthouse. This electricity is stored; and the inventor claims that this storage device is "so perfect" that he can furnish the full 150,000 C. P. demanded, even after "a dead calm of six months." He has an arrangement by which he can communicate to a distance of 30 miles by a series of electric flashes, and he can direct rays of light to any point of the compass, or up or down as desired. The frame of his lighthouse is to be of metal.

He claims cheapness and rapidity of construction; portability and the ease with which any part can be replaced. No full details are given, as these would interfere with application for patents; but he gives the cost at Auckland as $31,433, including the cost of erecting, testing and delivering free on board ship. The size and power of the light thus contracted for is not stated, other than is intimated in the text above given.

CONSTRUCTION NEWS.

RAILWAYS.

EAST OF CHICAGO.—Existing Roads.

Cincinnati, Wabash & Michigan.—The division of this road between Anderson and Rushville, Ind., about 40 miles, has been opened for passenger traffic.

Concord & Montreal.—This company has a bill before the New Hampshire State Legislature authorizing an issue of $3,000,000 of new stock. The proceeds are to be used for the extension of the Whitfield & Jefferson R. R. to Berlin and beyond, for providing terminal facilities at Nashua, for track and extension of coal facilities at Portsmouth, including an extension of wharves, for changing the line of track at Groveton Junction, for securing better facilities for connection with the Grand Trunk Line, and for providing additional and better accommodations and facilities at Nashua, Manchester, Laconia, Lake Village and other places on the various lines of the system. The corporation is contemplating extensive improvements along its line, especially at Manchester and Nashua. Under this bill no new stock can be issued except for the purpose of providing money to increase the property of the corporation and its facilities for doing business.

Fort Wayne, Terre Haute & Southwestern.—About 12 miles of the grading between Bainbridge and Carbon, Ind., have been completed and tracklaying is now in progress. The road is intended to run from Fort Wayne to Terre Haute, Ind., about 200 miles, and is being built by an independent company. It is probable, however, that it will be operated by the Louisville, New Albany & Chicago R. R. when completed. The offices of the company are in the Rialto Building, Chicago, Ill.

Lehigh Valley.—This company has secured the necessary legislation to run its Jersey City, Newark & Western R. R. through Bayonne, N. J. This road will cross Newark bay to West Sixtieth st., Bayonne, running along the western side of that street until it leaves the city. Then it crosses Morris Canal to Jersey City, and after a few blocks crosses the Central Railroad of New Jersey overhead, terminating at the shores of New York bay. Through Bayonne the road will be built upon a grade with some embankments for a roadbed.

Findlay Belt.—H. Paul, of Findlay, O., Chief Engineer, writes as follows:

The Findlay Belt railway is 20 miles long, and is being built to afford switching facilities for the various factories along its line. The route was partly surveyed in 1887, and a revised location was made in December, 1890. About 1 mile of the roadbed has been graded and work is in progress. It is expected to have the line open for business about May 1.

Gettysburg & Chambersburg.—John F. Stauffer, of Lancaster, Pa., writes us that this road will run through the towns of Fayetteville, Greenwood, and Greafenburg to Wolf Hill, Pa. Work is now in progress under the contractors, John F. Stauffer & Son. Tracklaying is expected to begin about March 1, and the road is to be opened for traffic in April The work is about average, the route being through a level country. There will be six or eight bridges, the longest about 200 ft. Samuel Culbertson, of Lancaster, Pa., is Chief Engineer.

Portland & Rochester.—A correspondent sends us the following information concerning this short line just completed through the city of Portland:

This line is about 4,000 ft. long, and runs through the town of Deering and the city of Portland. The work was about average; maximum grade 1% and maximum curve 10°. There are two iron bridges at street crossings, 110 ft. long and 34 ft. long respectively. The contractor was R. D. Shanahan, and S. S. Stephenson, of Goshan, Me., was the engineer in charge of work.

Canadian Pacific.—The Basses Laurentides Ry. has been completed from the Piles branch of the Canadian Pacific Ry. to the Quebec & Lake St. John Ry., but will not be opened till the spring.

Delaware & Hudson Canal Co.—The Ticonderoga R. R., running from Ticonderoga to the D. & H. C. Co.'s lines, 2.31 miles, has been completed.

Projects and Surveys.

Cobourg, Northumberland & Pacific.—Henry K. Wicksteed, of Cobourg, Ont., Chief Engineer, writes as follows:

This road is projected to run from Cobourg, Ont., northeast through Baltimore, Barnley, Warkworth and Campbellford to Central Ontario Junction, on the Canadian Pacific Ry., a distance of 40 miles. The preliminary surveys have been completed, and location will begin in about 6 weeks. The route is through a good agricultural section. The work will be generally easy; maximum grade 1% and maximum curve 6°. There will be one bridge over the Trent River, near Campbellford. The principal business of the road will be in agricultural produce, lumber, manufactured products and general merchandise. Local bonuses to the amount of $80,000 have been voted, and about $30,000 more is expected. In addition a Dominion subsidy of $96,000 is expected, together with a grant from the Provincial Government. In all an amount of $300,000 will be secured in aid of the enterprise. The estimated cost of the road is $600,000. The Canadian Pacific Ry. Co. will equip and operate the road when completed. Robert Muholland, of Cobourg, Ont., is President.

Annapolis & Atlantic.—Robert G. Herves, of Brockville, Ont., President and Chief Engineer, writes as follows:

This road is projected to run from Annapolis, N. S., to Liverpool, N. S., with a branch from Kempt or Caledonia Corners, to Shelbourne, N. S., a total distance of 130 miles. The preliminary surveys have been completed, and the line will be located as soon as the weather will permit. The work is quite light. It is intended to have no grade exceeding 1%, and no curve sharper than 5°, with the exception of a short section over the mountain near Annapolis. The route will pass through the gold mining district, and large tracts of timber land. The principal business will be in mining supplies and lumber, iron ore, apples, and the general merchandise to and from the vessels entering the harbor at Annapolis. The right of way has been donated by the counties along the route, and subsidies amounting to $6,400 per mile have been granted by the Provincial and Dominion governments. The remainder of the capital will be supplied by a syndicate. No contracts have yet been let, but the President is authorized to let contracts as soon as he may see fit, and it is expected to have a portion of the road completed this year. The company was chartered in 1888, and the charter was amended in 1890.

Oil Valley.—S. A. Mundy, of Bradford, Pa., Chief Engineer writes as follows:

This road is projected to run from Watsonville to Wilber Station, Pa., a distance of 20 miles. The route is through a heavy forest, and the principal business will be in lumber and oil. All the right of way has been obtained. The work will be done by the company, Chas. A. Weed, Binghamton, N. Y. President.

Southern Central.—A corps of engineers with headquarters at Dauphin, Pa., is now surveying the route of this road between Sunbury and Harrisburg, Pa.

Niagara Falls & Lewiston.—The Niagara Falls & Whirlpool Ry. Co. and the Niagara Falls & Lewiston Ry. Co. have consolidated under the title of the latter organization. The following officers have been elected: President, Capt. J. M. Brinker; Vice-President, Murray A. Verner; Secretary, Alexander White; Treasurer, R. W. Jones. Work on the line has been suspended on account of the cold weather, but will soon be resumed.

Nipissing & James Bay.—This railway company has purchased the right of way from Lanase, which is the northern terminus of the Nipissing Railway, to a point in the immediate vicinity of North Bay, and put it in readiness for construction of the road. The Ontario government has granted the company a bonus of $3,000 per mile for the first 50 miles which will take the road to Lake Samogeaming. Eighty miles will be the length of the first section, extending from North Bay to Lake Temiscamique. Application will be made to the Dominion Parliament at the next session for the usual bonds, and if secured the directors intend to commence construction at once.

Laurel & Roaring Point.—This company will obtain a charter from the Delaware Legislature empowering it to build a railway from Laurel, Del., to the Chesapeake Bay. Sufficient capital to build the line has been subscribed, and it is stated that work will begin at once. The road will pass through a fine fruit growing section.

St. Lawrence & Northwestern.—The promoters of this railway are in negotiation with an English firm for the money necessary for the construction of the road and hope to be able to commence operations in the spring. The road, as projected, starts from the St. Lawrence at Three Rivers and runs into the interior in a northwesterly direction to the river Matawan, a distance of about 70 miles.

SOUTHERN.—Existing Roads.

Atlantic & Danville.—The Danville & East Tennessee R. R. Co. is advertising for bids for constructing a portion of its line from Danville, Va., west. The road will run from Danville, Va., to Bristol, Tenn., and work will begin at both ends. Bids will also be received until March 1 for supplying 75,000 white oak or post oak cross ties, dimensions, 7 ft. × 8 in. × 9 in. J. W. M. Draper, Chief Engineer, Danville.

Morristown & Cumberland Gap.—A press report states that this railway from Morristown to Cumberland Gap, Tenn., has been completed.

West Virginia Central & Pittsburg.—Officials of the Grafton & Greenbrier R. R., running from Grafton to Phillipi, W. Va., 24 miles, are reported as saying that the track would be changed to standard gage at once.

Georgia Southern & Florida.—A press dispatch says:

The Macon Construction Co. and the Georgia Southern road expect to separate, and the road will be operated independently of the company. General Manager Lane of the Georgia Southern will leave the road and devote all of his time to the general management of the affairs of the Macon Construction Co. and the Macon & Savannah Construction Co. Col. W. G. Raoul, at present the President of the Mexican National Ry. and formerly President of the Central Road, will be tendered the Presidency and the position of General Manager of the Georgia Southern road at a large salary. The Georgia Southern road has purchased the Macon & Dublin road, which promised to be something of a rival to the Macon & Atlantic, a companion road of the Georgia Southern. Only 10 miles of the Macon & Dublin road remains to be graded. The distance from Macon to Dublin is 54 miles. The plan of the Macon & Dublin was to build from Dublin to Savannah and the Macon & Atlantic expects to build from Macon to Savannah also.

Branchville & Bowman.—Rails sufficient to lay an additional 4 miles of track on this South Carolina railway have been purchased. This will make the line about 9 miles long.

Central R. R. of Georgia —It is rumored that this company will build a branch from its main line between Macon and Savannah, Ga., to Sandersville, Ga.

Paducah, Tennessee & Alabama.—This road will be completed to Paris, Tenn., by Feb. 1. The 1,300 ft. trestle at Paris is nearly completed. Preliminary surveys have been made south from Paris to the Nashville, Chattanooga & St. Louis R. R., at Hollow Rock, Tenn.

Burnside & Cumberland River.—C. W. Cole, Chamber of Commerce Building, Cincinnati, O., President, writes as follows:

This road is 1¼ miles long and is intended to connect the Cincinnati Southern Ry. with the Cumberland River at Burnside Landing. The principal business is in lumber, stoves, spokes and cross ties. It will do no passenger business at present. J. W. Gunn was Chief Engineer.

Projects and Surveys.

Georgia, Tennessee & Illinois.—In our issue of Dec. 6 an item appeared under this head stating that L. F. Bellinger was not Chief Engineer of the company. Mr. Bellinger has written us that we were misinformed, and that he does hold that office.

South Florida & Georgia Air Line.—The surveys have been completed from Quitman to Tampa, Fla., and the engineers are now at work on a line via Brooksville and Dunnellon, Fla., to a point west of Quitman. Jos. Tillman, Quitman, Fla.

Dalton & Gainesville.—Surveys will begin at once for a railway from Dalton to Gainesville, Ga., Col. C. H. Hamilton, of Dalton, Ga., is at the head of the enterprise.

Pennsboro & Auburn.—Organized in West Virginia to build a railway from Pennsboro to Auburn, W. Va.

Louisa & Southeastern.—Jay H. Northup, of Ashland, Ky., General Manager, writes us as follows:

This company was chartered May 12, 1890, and surveys have already been made for a line from Louisa, Ky., via Warfield, Ky., to the Mouth of Pigeon, W. Va., where connection is much with the Norfolk & Western R. R., a distance of 40 miles. The route is along the Tug Fork of the Big Sandy River, and the construction will be principally hillside work and bottom land along the stream. Work has just been commenced securing right of way. No local aid has been received yet, but liberal donations of mineral lands are expected. The principal business of the road will be in coal, coke and general merchandise. The road is being built in the interest of the Ohio & Big Sandy R. R. Contracts will be let about May 1. H. E. Huntington is President and B. F. Thomas is Chief Engineer.

Hartford & Fordsville.—T. J. Smith, of Hartford, Ky., President, writes as follows:

This road is projected to run from Hartford, Ky., via Sulphur Springs, to Fordsville, Ky., 19 miles. The route

is over an old survey, made in 1888. No arrangements have been made for a resurvey. The work is generally easy. There will be one bridge across Rough River. The principal business of the road will be in coal, iron and timber.

Chicago, Evansville & Chattanooga.—J. E. Williamson, Evansville, Ind , writes us as follows:

This road is projected to run from Evansville, Ind., via Henderson, Hartford and Bowling Green, Ky., to Chattanooga, Tenn., about 255 miles. The grades are to be limited to 1% and the curves to 6°. There will be two bridges across the Green River. The principal business of the road will be in lumber, coal, tobacco, farm products and general merchandise. About $350,000 local aid will be obtained for the first 100 miles. A. B. Fitch, of Terra Haute, Ind., is Chief Engineer.

NORTHWEST.—Existing Roads.

Duluth & Winnipeg.—This company will build a spur 8 miles long to the iron ore beds recently discovered in section 36, township 55, range 26.

Minneapolis, St. Paul & Sault Ste. Marie.—This company contemplates building an extension from its North Dakota line to Regina, Alberta.

Escanaba, Iron Mountain & Western.—It is reported that this railway running from Escanaba to Iron Mt., Mich., 53 miles, has been sold to the Chicago & Northwestern R. R.

SOUTHWEST.—Existing Roads.

Waco, Lampasas & Llano.—Work on this Texas Railway is progressing rapidly. About 400 hands are now working between Lampasas and the Colorado River. The engineering corps is surveying west of the river, and as soon as the road is located from Lampasas to Llano the location of the division from Lampasas to Gatesville will begin, and the work of grading that section of the road is expected to begin in the spring.

Houston, Central Arkansas & Northern.—This company has given a mortgage of $20,000 per mile on its line, the proceeds to be used in the construction and equipment of the road. The road is now completed from McGehee, Ark., to Columbia, La., about 105 miles, and the grading is nearly completed on the section from Columbia to Alexandria, La. Nearly all of the ties are on hand, and tracklaying will begin in about two months. Work on the bridge across the Red River has been stopped on account of high water. This bridge is to be 800 ft. long with a draw span of 360 ft.

Fort Worth & Rio Grande.—Surveys are now in progress on the extension from Comanche to Brownwood, Tex. The line will be located ready for grading in a short time, and work will be pushed as fast as possible.

Louisiana Nickel Plate.—W. G. Wadley, of Houghton, La., Manager, writes as follows:

This road is projected to run from a point on the Vicksburg, Shreveport & Pacific R. R., near Houghton, La., north through the timber lands toward the Arkansas line. About 3 miles of the grading are already completed and tracklaying will begin in about one month. The road will do only a lumber business at present and will be extended from time to time as the lumber interests demand.

Projects and Surveys.

Springfield, Sedalia, Marshall & Northern.—The surveys for this road have been commenced under the direction of A. M. Nelson, Chief Engineer.

Kansas & Missouri.—Chartered in Kansas to build a railway from Boonville, Mo., to Topeka, Kan. Among the directors are: H. W. Wilkins, Kansas City, Kan., and W. R. Taylor, Wichita, Kan.

ROCKY MT. AND PACIFIC.—Existing Roads.

Northern Pacific.—The entire line from Chehalis to South Bend, Wash., 54 miles, has been located. The heaviest grade on the west side of the divide, on the Willapa River, is 95 ft. per mile, and on the east side 75 ft. per mile. With the exception of about 8 miles over the divide the grades are very light. About 250 men are now at work on the eastern end. The first shipment of rails and iron work has arrived and tracklaying will begin soon.—The grading is nearly completed on the line to Acosta and is entirely finished to Aberdeen, Wash. The line is already in operation to Montesano.—An extension of the Seattle, Lake Shore & Eastern R. R. from Snohomish to Everett, at Port Gardiner is talked of.—Surveys are now in progress for a line from Grand Coulee, Wash , north to the Columbia River and Foster Creek. The length of the line will be about 45 miles, and it will penetrate a rich mining district.

Pecos Valley.—This road has been opened for traffic between Pecos City, Tex., and Eddy, N. Mex.

Canadian Pacific.—This company has mortgaged $2,600,000 of bonds, the proceeds to be used in building the Souris Branch and the Columbia & Kootenai Ry.

Projects and Surveys.

Kettle Falls & Columbia Valley.—This company has been chartered to build a line of railway in Washington. The road is to run through the Columbia Valley to the mouth of the Spokane River, thence to Wallula Junction, where it will connect with the Union Pacific and the Northern Pacific railways, and thence to some point on the Columbia near that place. The officers are as follows: Henry D. Bushnell, President; William H. Reid, of Rochester, N. Y., Vice-President and Treasurer, and Henry D. Quimby, Secretary. A large amount of the preliminary work has been done, and the final survey will be pushed as rapidly as possible. The company also proposes establishing lines of steamers on both the Lower and Upper Columbia.

Rocky Mt. Ry. & Coal Co.—This company will apply to the Dominion Parliament for an act empowering it to construct a railway from the Canadian Pacific Ry. at Anthracite to the Red River.

CITY TRANSIT.

Electric Railways.—New lines or extensions of existing systems are proposed at Owensboro, Ky., address the mayor; Lebanon, Pa.; Gloversville, N. Y., address D. B. Judson; Braddock, Pa., address the Braddock & Turtle Creek Street Ry.; Denver, Colo., address the University Park Electric Ry.; Aransas Pass, Tex.; Harmon, Colo.; Winsted, Conn., address H. Gay and E. A. Nellis; Belfast, Me.; Collinsville, Mo., address L. Robinson or J. S. P. Gordon; New Haven, Conn., address the New Haven & West Haven Horse R. R.; Owensboro, Ky.; Chelsea, Mass., address the East Middlesex Horse R. R.

Biddeford, Me.—The Pepperell and Laconia mills have filed an objection to the Biddeford & Saco R. R. running its cars by electricity.

Norwich, Conn.—The Norwich Street Ry. will probably extend its lines and introduce electric motive power.

Winsted, Conn.—Henry Gay and others have applied for a charter for the Winsted Street Ry., to be operated by electricity.

Johnstown, N. Y.—At a recent meeting of the Johnstown, Gloversville & Kingsboro Horse R. R. a committee was appointed to prepare plans and estimates for the conversion of the line to an electric road.

Jamestown, N. Y.—The Jamestown Street Ry. has secured the right of way for an electrical street railway from this town to Lakewood, 5 miles distant. The rails have been ordered, and construction will begin as soon as the weather permits.

Brooklyn, N. Y.—The Coney Island & Brooklyn R.R. has filed a certificate with the Secretary of State for a 2-mile double track extension.

Lancaster, Pa.—The Electric Ry. is reported to have secured control of the Millersville line, and will convert it at once to an electric road.

Beaver Falls, Pa.—The Beaver Valley Street Ry., operating a horse car line to New Brighton, has decided to change its motive power to electricity early in the spring. The capital of the company has been increased from $30,000 to $60,000.

Baltimore, Md.—The South Baltimore Harbor & Improvement Co. wants prices on an electric railway plant.

Atlanta, Ga.—A. E. Thornton, President of the Atlanta Street Ry , is reported as saying that construction will begin on a number of new electric lines within 30 days.

Cincinnati, O.—President Kilgour of the Cincinnati Street Ry. has accepted the terms and conditions of the ordinance providing for the extension of Route No. 5 and the Cincinnati & Clinton division, and also for the use of electric motive power.

Milwaukee, Wis.—The Milwaukee & Wauwatosa Rapid Transit Co. has been revived by J. Wechselberg and Capt. Pabst.

Racine, Wis.—It is reported that President Charles Hathaway, of the Belle City Street Car Co., has gone East to buy rails, cars and motors necessary to change the present system into an electric road.

Denver, Col.—The Denver, Lakewood & Golden electric line has obtained an entrance into the city over the track of the Tramway Co., and will make a number of extensions at other places on its system.

Omaha, Neb.—The Interstate Bridge & Street Railway Co. has been organized with a capital stock of $2,500,000 by R. C. Cushing, H. W. Yates and A. S. Potts. The company will probably construct an electric line to East Omaha.

Oakland, Cal.—A franchise for a cable road was granted to E. Politz, W. H. Grosmeyer and others in 1889 The road was never begun, and application is now made for a modification of the franchise to allow it to be operated by electricity.

Elevated Railways.—*Brooklyn, N. Y.*—The Seaside & Brooklyn Bridge Elevated R. R. has applied for permission to begin the construction of its lines, which are continuous with those of the Brooklyn & Union system, and will afford rapid transit facilities southward to Fort Hamilton. Simon Uhlmann is president and Hugo Rothschild secretary of the company.

Horse Railways.—Lines are proposed in Knoxville, Tenn., by the West End Street R. R., and in Terrell, Tex.

New Haven, Conn.—H. B. Bigiow and others have applied for a street railway franchise. Horses will probably be used, although electricity is under discussion.

Alexandria, Va.—The Washington Southern R. R. and the City Council have come to an agreement, by the terms of which the railway will repair and pave the streets on which tracks are laid and the city will allow the railway undisturbed possession as long as it holds to its promises. The matter has been under dispute for some time.

Berkeley, Cal.—Messrs. Raymond & Bay, of San Francisco, are now preparing plans and estimates for the Claremont University & Ferries Street R. R. in this city. The motive power, either horses or electricity, has not yet been determined.

Dummy Railways.—*Spartanburg, S. C.*—It is reported that grading will soon begin on the line of proposed dummy railroad, of which A. H. Leftwich is president.

Knoxville, Tenn.—The South Knoxville Street Car Co., organized by R. A. Dawson and others, will build a heavy standard gage dummy line about 6 miles long.

Cable Railways.—*New York City.*—Col. Lamont is reported to have said that the castings for the Broadway cable conduit are now being made, and work will soon begin on the construction. The company may, it is said, erect an 8-story building at the corner of Broadway and Houston St. The basement will be used for the power plant and the rooms above for offices.

Washington, D. C.—The Washington & Georgetown R. R. will soon begin the preliminary work on its power house, which will be 241 × 185 ft., 6 stories high, and cost, so it is reported, about $450,000.

Chicago, Ill.—The cost of operating cable cars on the Chicago City Ry. during the past year was 9.65 cts. per mile; with horses 21.985 cts.; number of miles run by cable, 12,740,480; by horses, 4,859,200. The daily cost of each horse was 47.65 cts. The cable system is composed of 13 cables, aggregating 205,040 ft. in length. The loop cables are operated at a speed of 7½ miles an hour, and others at 10, 11 and 14 miles.

Underground Road.—*Baltimore, Md.*—The construction of the belt line tunnel under the streets occupied by the Traction Co. has presented a number of difficulties. The shafts were first sunk between the sidewalk and the Traction Co.'s conduit to a depth of 23 ft., and drifts run under the stret at this level. The conduits are of concrete, 3 ft. deep, and have sunk as much as 3 ins. in places on account of the action of the quicksand before a sump was driven and the sand controlled.

New Companies.—Waynesboro & Basic City St. Ry., Waynesboro, Va.; J. T. Smith president; W. M. Chew secretary. Polytechnic St. Ry., Fort Worth, Tex.; capital stock, $100,000; incorporators, W. D. Hall, J. S. Andrews, E. A. Brockman. Beaumont St. Ry., Knoxville, Tenn.; incorporators, L. Jourolman, C. M. McLung, B. J. Briscoe. Dunkirk & Fredonia Rapid Transit Co., Fredonia, N. Y.; capital stock, $90,000; incorporators, W. Martin, O. W. Johnson, R. B. Day.

HIGHWAYS.

New York.—The new highway between Savannah and Galen has been completed at a cost of about $9,000. The road is 22 ft. wide.

Mississippi.—The Board of Supervisors of Lauderdale Co., at Meridian, have awarded the contract for working the public roads to W. F. Buchanan, of Chickasaw Co., for a term of 5 years at $10,000 per annum. This is under a plan adopted by the Board for keeping the public roads in repair by contract. The county prisoners have also been leased to Mr. Buchanan for 5 years, and he will employ them on the roads.

BRIDGES, TUNNELS AND CANALS.

Bridges.—*Oswego, N. Y.*—A bill has been introduced into the Assembly appropriating $15,000 for a bridge across the Erie canal at this place.

Rome, N. Y.—A bill appropriating $4,000 for a canal bridge at this place has been introduced into the New York State Assembly.

Pittsburg, Pa.—The Aspinwall Bridge Co. has been chartered to build a bridge over the Allegheny River, between Aspinwall and Pittsburg. B. L. Wood, Jr., of Pittsburg, is a director.

St. Louis, Mo.—The Board of Public Improvements will proceed at once to obtain bids for the steel work on the Twenty-first street bridge; the steel work on Weber Road bridge over Gravois Creek; furnishing and erecting steel work and relaying on Knox avenue bridge; constructing stone work on Knox avenue bridge over the River des Peres, and for cedar block paving on East Jefferson avenue bridge.

Rayville, La.—The New Orleans & Morristown Ry. Co., New Orleans, La., contemplates the construction of a drawbridge across the Rœuf River, about three miles north of Rayville, La.

WATER-WORKS.

NEW ENGLAND.

Phillips, Me.—The following is from Mason Parker:

The Phillips Water & Electric Light Co. has applied to the legislature for a charter.

Franklin, N. H.—Bids are wanted by the Water Commissioners until Jan. 31 for laying about 6 miles of 10 to 4-in. cast-iron pipe. F. L. Fuller, 12 Pearl St., Boston, is Engineer.

Lowell, Mass.—Bids for a new 10,000,000 gall. pumping engine were opened Jan. 16, and referred to George H. Barrus of Boston, Consulting Engineer, who was appointed on the above date. The highest bid was by the Builder's Iron Foundry, Providence, R. I., $52,000, based on an engine designed by F. W. Dean; duty of 100,000,000. The lowest bid was that of the Deane Steam Pump Co., Holyoke, Mass., $23,780; duty, 70,000,000 ft. lbs. The E. P. Allis Co., Milwaukee, offered to build an engine with a duty of 125,000,000 ft. lbs. for $52,000. The duty test will be

conducted in accordance with the recently adopted standard of the American Society of Mechanical Engineers.

Woonsocket, R. I.—Byron I. Cook, Superintendent, informs us that the Water Commissioners have recommended the addition of a pumping engine and force main. If the city makes the necessary appropriation the improvements will be made.

Windsor Locks, Conn.—Important extensions to these works were made in 1890 by the Windsor Locks Water Co. The works were built in 1889, but as no contract had been made with the village for fire protection the pumping plant was designed to give only an ample supply for domestic use. The supply is taken from springs with a minimum daily capacity of 800,000 galls., and is lifted by a power pump driven by a water wheel under a 40-ft. head to a stand-pipe 40 ft. in diameter by 100 ft. high. Since the works were completed a contract to furnish fire protection has been made, and a pumping station with a 1,000,000-gall. compound duplex pump and a 54-in. boiler have been added. The new pump will be used only in case of fire, but a banked fire will be kept under the boiler. The ordinary pressure in the business part of the village is 80 lbs. The works were built with Dunham & Paine, New York, as Engineers, and S. P. Townsend & Son, Hartford, Contractors.

MIDDLE.

Holland, N. Y.—The following is from W. B. Jackson:

The Holland Water-works Co. proposes to build works, commencing construction about May. The supply will be from springs, and the cost is estimated at $10,000. Population, about 800.

Kearney, N. J.—A petition bearing the signature of 113 persons and asking for the erection of a stand-pipe or tower in Arlington has been presented to the Township Committee and referred by them to the Fire Committee.

Lebanon, Pa.—Plans for a large reservoir have been made by the City Engineer, and construction may be started in the spring.

Brunswick, Md.—The following is from W. L. Gross, Secretary:

The Brunswick Water Co. proposes to build gravity works costing from $6,000 to $9,000. The plan includes a reservoir. Population, 800, and increasing.

Hagerstown, Md.—C. F. Manning, Superintendent, informs us that a 1,000,000-gall. Smith & Vaile pump is about to be added for use, if needed, during the dry summer months.

SOUTHERN.

Glen Dale, W. Va.—Works are projected by the Glen Dale Co. This company was recently incorporated by Geo ge Adams, William Erskine and others to make various local improvements.

Grafton, W. Va.—The following is from John J. Gilligan, Clerk:

There are several propositions before the city for the construction of works on the franchise plan, but it is likely that the city will build. If an ordinance now under consideration passes bonds will be issued for works estimated to cost $50,000. It is proposed to take water from Valley River. There will be a reservoir. Population, 4,500.

Newberry, S. C.—Address the Mayor regarding proposed works. It is reported that a public meeting to consider the subject is to be held.

East Rome, Ga.—A tax of ¼ of 1% has been voted for works.

Attalla, Ala.—The following is from L. B. Whatly:

Preparations to issue city bonds for works are being made, and bids will be wanted about March 1; estimated cost, $25,000. The proposed supply is from a spring, and the plan includes a reservoir. Population, 2,000.

Bridgeport, Ala.—The following is from W. H. Brundige, Superintendent:

The Bridgeport Water-Works Co. put their works in operation Nov. 1, 1890, but they are not yet completed. Bids for a stand-pipe, to be erected in March are wanted, and also for 6 and 8 in. pipe, delivered. All taps are metered.

Shelby, Ala.—E. S. Safford, Chief Engineer, informs us that the works of the Alabama Coal & Iron Co. were put in operation Jan. 15. Direct pumping is used.

Uniontown, Ala.—The following is from J. Welch, Mayor:

The city hopes to begin the construction of works about Feb. 1. Water will be pumped to a stand-pipe 15 × 80 ft. The works are estimated to cost $25,000. Population, about 2,000.

North Knoxville, Tenn.—The Mayor has vetoed the ordinance passed Jan. 2, granting a franchise to the Tillery Springs Co. The ground for the veto was that proper legal advice had not been had, and objectionable features in the franchise. The Council passed a motion authorizing the Mayor to employ legal advice regarding the two propositions which have been made.

Tracy City, Tenn.—It is reported that works will be built by W. H. Whitcombe & Co., Norway, Me.

Owensborough, Ky.—It is reported that new pumps are being added.

Richmond, Ky.—Charles S. Powell, Secretary, informs us that the Richmond Water & Light Co. expect to have their works in operation May 1. Construction was begun in August. Water is to be pumped from a creek to a tank and direct. Population, 5,050.

NORTH CENTRAL.

Carthage, O.—Harry Simms, Secretary, informs us that the village works will be in operation about April 1. All the contracts have been let. Direct pumping is used. Population, 2,500.

Cincinnati, O.—The Wilson-Snyder Manufacturing Co., Pittsburg, Pa., have been awarded the contract for the new vertical pumps; price, $48,000.

The Committee on Water-works of the East End Improvement Association has reported in favor of the construction by the city of new pumping works, subsiding reservoirs with a capacity of 200,000,000 galls., and two storage reservoirs with a combined capacity of 1,800,000,000 galls.; the reservoirs to be in excavation and embankment. High and low service pumping systems are recommended, as also are the present Eden and Third St. reservoirs for distribution. The plan has been submitted to George Hornung, C. E., of Cincinnati, who states that, though the data are meager the plan, especially that portion relating to the reservoirs, approaches nearer to his views on the subject than any preceding plan. E. H. Griest is President of the association, and L. B. Robb was Chairman of the commitee.

Belvidere, Ill.—It has just been ascertained that the $35,000 of bonds voted for water-works is more than the town can legally issue. The contract for works has already been let to G. C. Morgan, Chicago.

NORTHWESTERN.

Wilton, Ia.—J. Giesler informs us that small pumping works will be put in operation by the town Feb. 1.

Atkinson, Neb.—The works were tested Jan. 10; cost, $7,000.

Faulkton, S. Dak.—G. A. Morse, Mayor, informs us that mains will be laid this season.

Gettysburgh, S. Dak.—E. D. Packer informs us that nothing has been done toward completing the well referred to in the MANUAL OF AMERICAN WATER-WORKS for 1889-90, but it is wished that some one would further the project. The well was carried down 1,300 ft. by the village into shale without finding water.

SOUTHWESTERN.

Butler, Mo.—A recent water-works election has resulted in a vote of 420 to 120 in favor of works. The franchise has been granted to F. G. Tygard, J. C. Clark, J. R. Jenkins and W. E. Walton, all of Butler; works are to be completed by Sept. 1.

Stuttgart, Ark.—T. H. Leslie informs us that the Stuttgart Improvement Co. propose to build this year the works projected to be built in 1890.

Bastrop, Tex.—The following is from T. A. Hasler, Treasurer:

The Bastrop Improvement & Investment Co. is now ready to build works to cost from $12,000 to $15,000, including a pumping station and a steel stand-pipe. Plans and specifications can be had by addressing the Treasurer, or J. C. Buchanan, President.

Denton, Tex.—The following is from W. J. Williams, Dallas, Contractor for the works:

The Denton Water, Light & Power Co. will begin the construction of works in March and complete them by July 31. Artesian wells are now being sunk. The works are estimated to cost $50,000. J. Rourke is President, W. J. Williams, Vice-President, and D. Hand, Treasurer. Population, 3,500.

Fort Worth, Tex.—It is reported that owing to the increase in the extent of the distributing mains without a corresponding increase in the pumping capacity the supply is inefficient, and that insurance men and citizens are asking for better service.

Temple, Tex.—It is reported that a stand-pipe will be erected in place of the one which recently burst.

Wichita Falls, Tex.—The following is from O. T. Bacon, Mayor:

D. A. Chappell, Trinidad, Col., has the franchise to build works and Morgan Jones, President of the Fort Worth & Denver R. R. Co., Fort Worth, is also interested. P. H. McCrickett is engineer. Water will be pumped from gang and artesian wells to a 100,000-gall. stand-pipe by a 1,000,000-gall. pump. The city will pay $2,250 a year for 45 hydrants. Population, 3,500.

Antonito, Col.—S. W. Hatch, Recorder, informs us that bonds for works have been voted, and that water will probably be introduced this year.

Colorado Springs, Col.—E. W. Frost, Superintendent, informs us that $80,000 will be spent for new pipe, hydrants, a reservoir and additional water rights.

Roswell, N. M.—Artesian water has been struck at a depth of 207 ft. on the premises of Prager & Jaffa. Water rose 1 ft. above the ground. The well will be sunk deeper It is stated that this is the second well in New Mexico.

PACIFIC.

Seattle, Wash.—At a recent meeting of the Board of Public Works, Superintendent Chalk made a report concurring with Engineer Benzette Williams regarding extensions to the works. According to the Seattle *Post-Intelligencer* it was recommended that:

Another set of pumps of greater capacity than those now at the station be furnished; that a 20-in. discharge pipe be laid connecting the pumps with the reservoir; that the new reservoir be built at once and a connection made with it from the old reservoir by attaching to the 30-in. main now being laid, with proper cut-offs to divide the lower from the higher system; then lay a pipe line as planned. A reduction was recommended in the size of the reservoir to be built with a view of enlarging it in the future. The cost of these improvements was estimated as follows: Pumps and boiler, $20,000; force main from pumps to old reservoir, distance 7,200 ft., 20-in. pipe, $32,400; two condensers, $3,000; inlet pipe and pump well, $5,000; new reservoir, $106,000; 42-in. main from Yesler Ave. to upper reservoir, 19,500 ft., $71,250; total cost, $237,650. To this is to be added the cost of land for the reservoir. The report was placed on file.

Snohomish, Wash.—A resident has sent the following: A private company will begin the construction of works estimated to cost $50,000 in about three months. Water will be pumped from Pil Chuck Creek to a stand-pipe. Population, 2,500. Address E. C. Ferguson for further data.

Vancouver, Wash.—The following is from L. M. Hidden, Vice-President and Manager:

The Columbia Land and Improvement Co. are now laying 1½ miles of pipe, with more to follow. The supply is from a well on a hill back of the river and is pumped to a stone reservoir. Another pump and well may soon be added, the latter to be 8 ft. square for 100 ft. in depth, with four 12 in. pipes driven in each corner.

Monrovia, Cal.—C. O. Monroe informs us that the town is extending its supply mains further up the Snow Pit Canon to springs.

Oakland, Cal.—John R. Glascock, Mayor, informs us that the city has not voted and does not contemplate voting an appropriation for the construction of its own water-works, as has been reported.

Boise City, Ida.—Alfred Eoff, Secretary, has sent the following:

The Boisé City Water-Works Co. put works in operation Dec. 1. Their supply is from artesian wells, by gravity. The wells are about 150 ft. above the city and have a daily flow of about 2,500,000 galls. The Artesian Water & Land Improvement Co. are developing a water supply.

CANADA.

Kingston, Ont.—T. B. Craig has sent us the following:

The contract for a new suction pipe, material and labor has been awarded to the lowest bidder, A. Rousseau, Montreal, for $9,235. The highest bid was $16,000, by W. McNamee, Montreal, and the Bridge Works, Peterborough, Ont., jointly.

ARTESIAN WELLS.

Gordon, Ga.—It is reported that the contract for a well has been awarded to L. B. Clay, Bartow, Fla.

Okolona, Miss.—James Williams informs us a contract for an artesian well has been partially made; estimated cost, $10,000.

Waukegan, Ill.—Two artesian wells, each 2,000 ft. deep, are projected by the city, in connection with improvements, to induce the Washburn-Moen Co. to establish works in the city.

Brown Co., S. Dak.—The Dakota Irrigation Co., of Aberdeen, has contracted to sink three more artesian wells in this county. The company hopes to put down 12 or 15 wells during the coming season.

Bremond, Tex.—The Houston & Texas Central R. R. Co. propose to sink another artesian well. Two have been sunk, unsuccessfully.

Cleburne, Tex.—It is reported that E. S. Moss will sink an artesian well.

Corsicana, Tex.—The American Well & Prospecting Co., Salina, Kan., are sinking a well for the town.

Palestine, Tex.—There is talk of organizing a company to sink and operate artesian wells. It is thought that the town would grant valuable franchises to a company. M. Hinzie is mayor.

IRRIGATION.

New Mexico.—A dispatch to the New York *Herald* states that the Rio Grande Irrigation & Colonization Co. have started a survey for a dam on the Santa Ana River, about 15 miles from its mouth, and a ditch to irrigate a large tract of land. P. B. Smith, New York, is said to be Manager and Mr. Anderson, of Denver, Engineer.

Lethbridge, N. W. T.—D. W. Davis, C. E. D. Wood, Editor Macleod *Gazette*, Dr. Kennedy, of Macleod, and John B. Bright, C. E., Lethbridge, propose to apply to the next session of the Dominion Parliament for the incorporation of an irrigation company. It is proposed to construct a canal and flumes with a combined length of 30 miles, which will furnish water to about 150,000 acres of land; estimated cost, $75,000. Water will be taken from Old Man's River, near Macleod.

SEWERAGE AND MUNICIPAL.

Sewers.—*Brooklyn, N. Y.*—A bill has been introduced for the appropriation of an additional sum of $500,000 for sewers in Ward 26

Newark, N. J.—The Commission appointed to assess benefits for the intercepting sewers have submitted a majority and a minority report to Judge Depue in the Circuit Court. The former recommends that the whole cost of the construction should be assessed upon the city at large, while the latter recommends that it should be assessed partly upon the owners of property benefited.

West Knoxville, Tenn.—It is proposed to issue bonds for $75,000 for sewer purposes.

Desplaines, Ill.—The village Board of Trustees has been discussing plans for drainage and sewerage, but nothing definite has yet been decided on.

St. Louis, Mo.—Work is progressing on the sewer tunnel under West Pine St., at the rate of about 16 ft. per day. It will be 2,900 ft. long, and 1,000 ft. have been complete since work was started last fall.

Montreal, Can.—Sewers are to be constructed on Balmoral, Nellie and Colony Sts.

Avondale, O.—Plans and specifications are on file for lateral sewers and drains. A. S. Hobby, 227 Main St., Cincinnati, is the engineer for the Board of Sewer Commissioners.

Streets.—*Pittsburg, Pa.*—The borough of West Bellevue will spend $12,000 in macadamizing and improving the streets.

Covington, Ky.—Granite paving is to be commenced in the spring; about $300,000 will be expended on the work.

Savannah, Ga.—Asphalt paving is proposed for the square and streets adjacent to the county court house.

Key West, Fla.—An ordinance has been proposed providing that curbs shall be set with a bevel of 1½ ins. per vertical ft., and joints filled with cement to a depth of 12 ins. from the top; the city to furnish the cement, and the contractors to perform the work without extra expense.

Omaha, Neb.—Mr. Tillson, city engineer, has made enquiries as to the pavements of various cities; he classes stone block and asphalt as first class, cobblestone and brick as second class, wood as third class.

Oakland, Cal.—The work done by the Superintendent of streets during the last six months of 1890 included 891,949 sq. ft. of macadamizing, at a cost of $83,945; 2,038 sq. ft. of artificial stone sidewalk, $414; 65,918 sq. ft. of bituminous sidewalk, $8,000. The total cost of street work is estimated at $50,000.

ELECTRICAL.

Electric Light.—New plants or extensions of existing systems are proposed in the following places: Danville, Va.; New Cumberland, W. Va., address the New Cumberland Light, Heat & Power Co.; Del Rio, Tex.; Macon, Ga., address J. C. McBurney, of Atlanta; Morgantou, N. C., address the Morganton Development Co.; Madisonville, Ky., address the mayor; Maysville, Ky., address the Maysville Gas Light Co.; Dayton, Tex., address the mayor; Greenwood, Miss., address the Planters' Oil Mill & Manufacturing Co.; Middlesborough, Ky., address the Middlesborough Electric Light, Heat & Power Co.; Birmingham Ala., address tae Stevens Electric Co.; Lexington, Va., address the Council Committee on Lighting; Pulaski City, Va., address the Pulaski Iron Co.; Bowling Green, Ky., address the Bowling Green Gas Works; Glen Dale, W. Va., address G. Adams or W. Erskine; Savannah, Ga., address B. W. Bentley; East Lake, Ala.; Oil City, O.; Shenandoah, Ia., address W. M. Croan; Milford, Neb., address J. H. Culver; Haselton, O.; Port Clinton, O.; Attalla, Ala., address L. B. Whatly.

Lockport, N. Y.—It is reported that a co-operative electric lighting plant will be installed by a number of merchants on Main St.

Brooklyn, N. Y.—The city has contracted for electric street lighting at $182.50 per lamp year, the same price as last year.

New York City—The following street lighting contracts have been awarded: United States Co., 290 lamps at 40 cts. per lamp per night; Brush Co. 136 lamps at 40 cts. and 69 lamps at 45 cts.; East River Co., 160 lamps at 40 cts.; Mount Morris Co., 122 lamps at 40 cts. per night per lamp; Harlem Lighting Co., 33 lamps at 40 cts., and 19 lamps at 50 cts.

Richmond, Va.—Mr. A. Langstaff Johnston, the electrical engineer of the majority of the street railways in this city, recently gave a successful public exhibition of a current breaker for rendering electric wires harmless, whenever they are broken, detached or torn from their position.

Richmond, Va.—At a recent meeting of the Committee on Electric Light, a resolution was introduced instructing the city engineer to prepare plans and estimates for a 400-arc and 1,500 incandescent light plant, the lamps to be of 2,000 and 16 c. p. respectively.

Lampasas, Tex.—W. A. Patterson, manager of the Elks Opera House, wants bids for furnishing an electric light plant.

Marquette, Mich.—Prices for electric lighting in this city during the past year were $30 per year for arc and 40 cts. per month for incandescent lights.

New Companies.—Chicago, Ill., Incandescent Light Co.; capital stock, $15,000: incorporators, C. S. Olmsted, E. S. Osgood, H. R. Husted. People's Electric Light & Gas Co., Birmingham, Ala.; capital stock, $100,000; incorporators, G. W. Beggs and J. E. Lee of Bessemer and H. T. Beggs of Birmingham. Idaho Electric Light & Power Co., Wallace, Idaho; capital stock, $500,000; directors, C. W. O'Neil and others. Kingman, Kan., Water & Light Co.; capital stock, $100,000; directors, V. C. Jarboe and others. Mullan, Idaho, Electric Light & Power Co.; capital stock, $10,000; directors, A. M. Strode, T. S. Hagan and others. South Denver, Col., Light Co.; capital stock, $100,000; incorporators, S. A. Josephi, L. P. Martin, S. Newhouse.

CONTRACTING.

Stone.—*Bridgeport, Conn.*—The following proposals for 10,000 tons of stone for the breakwater were received Jan. 15, by Col. D. C. Houston, U. S. Engineer Office, New York City: Brown & Fleming, New York, $1.29 per ton for New York stone and Connecticut River granite; John Beattie, Lectes Island, Conn., $1.35 for granite; Humphrey Toomey, Guilford, Conn., $1.50 for granite; F. H. Smith, New York, $1.94: Sherman Petrie, New York, $1.99 for granite; John A. Bouker, New York, $2 for New York stone; Thos. Anderson, Stratford, Conn., $2.17; Wm. H. Morton, $2.38 for stone from Housatonic River, Conn.

Dredging.—*Wilson's Point, Conn.*—The following proposals for dredging 125,000 cu. yds. were opened Jan. 15, by Col. D. C. Houston, U. S. Engineer Office, New York City: A. J. Beardsley & Son, Bridgeport, Conn., 8⅛ cts. per cu. yd.; Morris & Cumings Dredging Co., New York, 12⅝ cts.; Henry DuBois Sons, New York, 13 cts.; Hartford Dredging Co., Hartford, Conn., 14 cts.; Morris J. Brainard, New York, 16¼ cts.; J. H. Fenner, Jersey City, N. J., 17 cts.

Quincy, Ill.—The following proposals for dredging in Quincy Bay have been received by Major E. H. Ruffner, U. S. Engineer Office: H. S. Brown, Quincy, Ill., 12.4 cts. per cu. yd.; A. J. Whitney, Rock Island, Ill., 15 cts.

Removing Shoals.—The following proposals have been received by Major M. B. Adams, U. S. Engineer Office: Burlington, Vt., for removing shoals between Sister Islands and Crossover light, St. Lawrence River: Wm. J. Daly, Ogdensburg, N. Y., $16 per cu. yd.; Willard Johnson, Fulton, N. Y., $17.50; French & Jennings, Fulton, N. Y., $17.98.

Iron, Cement, Piles, etc.—*New York, N. Y.*—The following contracts have been awarded by the Docks Department: John Fox, 13,230 lbs. of wrought iron armature plates, 3.95 cts. per lb.; W. Ames & Co., 3,743 lbs. of cast-iron washers at 2 cts. per lb. Alexander Pollock, 2.8 cts. per lb. for screw-bolts, washers, strap bolts, round spikes, and lag screws. Baetjer & Meyerstein, 1,500 bbls. of Portland cement at $2.29 per bbl. A. J. Murray, $5 and $6.30 each for piles 55 to 60 ft. and 60 to 65 ft. long. Brown & Fleming, 49 cts. per cu. yd. for riprap stone, 94 cts. per cu. yd. for cobblestone. J. W. Duryea, $19.50 per 1,000 ft. B. M. for 3-in. spruce.

PROPOSALS OPEN.

Dam.—*Charleston, W. Va.*—Iron for dams in Great Kanawha River; 94,000 lbs. of wrought iron, 333,000 lbs. of cast iron. Col. W. P. Craighill, U. S. Engineer Office. Feb. 10.

Building.—*Sioux City., Ia.*—Stone building for public library and municipal offices. C. P. Brown, architect, 52 Metropolitan block. Feb. 3.

Street Work.—*Cincinnati, O.*—Grading, curbing, brick paving, boulder paving on cement foundation, culverts, drains, etc. Board of City Affairs. Feb. 7.

Syracuse, N. Y.—A large amount of Trinidad or Sicilian sheet asphalt paving. H. F. Stephens. Jan. 23.

Lighting.—*Columbus, O.*—For 5 years: 800 arc lights, 500 Gordon gas lamps, 800 open gas burners, 500 naphtha, gasoline, petroleum or other lamps. Board of Public Works. Feb. 4.

Jails.—*Camden, N. J.*—Erecting 36 iron cells, etc., in county jail. E. Evans, Chairman of Court House Committee, Haddonfield, N. J. Feb. 3.

Helena, Mont.—County jail to cost $45,000. J. S. Tooker, Clerk of County Commissioners. Feb. 12.

Bridges.—*New York, N. Y.*—Temporary bridge at Macomb's Dam. Department of Public Works, 31 Chambers St. Jan. 30.

Egypt.—Railway bridge across the Nile, between Mansourah and Talkha; 245 meters long. The Secretary of Egyptian Railways, Cairo, Egypt. Feb. 15.

MANUFACTURING AND TECHNICAL.

Locomotives.—The Rogers Locomotive & Machine Works, Paterson, N. J., have an order for 30 mogul engines, with cylinders 19×24 ins., for the Chicago, Burlington & Quincy. The dimensions of 3 powerful decapod engines for the same road are given in another column. The Schenectady Locomotive Works, of Schenectady, N. Y., have an order for 5 ten-wheel freight engines, 6 ten-wheel passenger engines, 3 six-wheel switch engines for the Chicago, St. Paul, Minneapolis & Omaha; they have delivered 2 engines to the Chicago & Eastern Illinois. The Manchester Locomotive Works, of Manchester, N H., have an order for 2 six-wheel switch engines for the Concord & Montreal. The Brooks Locomotive Works, of Dunkirk, N. Y., have shipped 6 heavy passenger engines and tenders to the Illinois Central. The Grand Trunk has built at its shops near Quebec 10 fast passenger engines, with cylinders 18×24 ins., and 74-in. driving wheels. The Ohio & Mississippi has built at its shops at Washington, Ind., 2 engines for fast passenger service. The Columbus, Shawnee & Hocking will purchase 4 or 5 heavy freight engines. The Chicago, Milwaukee & St. Paul, Illinois Central, and Chicago, Rock Island & Pacific will also give out orders for new engines. The Richmond Locomotive & Machine Works, Richmond, Va., were damaged by fire on Jan. 14.

Cars.—The Litchfield Car Works, of Litchfield, Ill., have built 20 coal cars for the St. Louis, Alton & Springfield. The St. Charles Car Co., of St. Charles, Mo., has built 25 coal cars for the same road. The Columbus, Shawnee & Hocking will place orders this spring for 1,000 standard coal cars of 30 tons capacity. The Columbus Steel Car Co. is erecting sheds at Desplaines, Ill., and will build its shops in the spring.

Railway Shops.—The Cincinnati Southern will erect a machine shop and roundhouse at Lexington, Ky. The Georgia, Carolina & Northern will build machine shops at Abbeville, S. C.

The Wisconsin Bridge & Iron Co. of Milwaukee, Wis., reports a good supply of orders on hand and business generally as good. Among other contracts there are four railroad bridges in Wisconsin, each with a 150-ft. span, and contracts on hand for about a dozen highway bridges in this state averaging 80 ft. in length, 16 ft. wide. It is also building a viaduct at Appleton, Wis., and at Seguin, Tex., is putting up a two-span bridge, spans 200 and 60 ft. respectively, on cylinder piers, 50 ft. high. A 200-ft. bridge is being erected in Greene Co., Ill., and 9 spans in Lockport, Ill., averaging 100 ft. in length. A number of small bridges are also being put up by this company in Michigan.

Railway Station.—A new station is to be built by the Boston & Maine, at Laconia, N. H. Mr. B. L. Gilbert, of New York, is the architect,

Portable Railway.—E. J. Meyer, Montgomery, Ala., wants 565 yds. of portable railway, with crossings; also 6 dump cars.

Dams.—In the construction of the dam across the Colorado River at Austin, Tex. (B. Corrigan, contractor), the largest "Locke-Miller" cable plant will be used, the main cable will be 1,850 ft. long, 2½ ins. diameter, of crucible steel. The plant was designed and furnished by the Lidgerwood Mfg. Co., New York. A bill has been introduced in the New York Assembly to appropriate $300,000 for a dam across the Hudson between Troy and Green Island. Surveys have been made by Capt. Wm. Martin, of Pittsburg, for the dam at Beaver, Pa.

The Milwaukee (Wis.) Bridge & Iron Co. is now constructing two bridges in Milwaukee; one a 180-ft. draw span at Michigan St., 18-ft. roadway and 7-ft. sidewalks; and one known as the North Ave. Bridge, two spans, 138 and 122 ft. respectively, 18 ft. wide. Both are over the Milwaukee River. The former will be completed in about three weeks, the latter about April 1. Among other contracts they are also building the Laurel Ave. Viaduct at Minneapolis, Minn., four spans, each about 80 ft. long, 20 ft. wide, two 8-ft. sidewalks, and a bridge for the North Augusta (Ga.) Land Co., consisting of three channel spans 205 ft. each, 30 ft. wide, two sidewalks, 7 ft. wide, and approaches 260 ft. long on each side. They have contracts on hand for a number of smaller highway bridges.

The Berlin Iron Bridge Co., of East Berlin, Conn., has built the highway bridge at Broad St., in Stamford, Conn.; it is an iron bridge, with 2 spans of 60 ft., a 30 ft. roadway and 2 walls 6 ft. wide. The floor is of iron buckle plates and concrete, with asphalt pavement. The company has erected an iron roof over the casting shop of the Montgomery Iron Co., at Port Kennedy, Pa.

The Laidlaw & Dunn Co., of Cincinnati, O., has purchased the entire plant of the Eclipse Mfg. Co., of Cincinnati, including patterns, drawings, tools, machinery, patents, etc.

New Companies.—Hydro-Pneumatic Power Co., of Chcago, Ill.; incorporators, J. T. Dyer and Richard Osburke; capital stock, $120,000. Independent Powder Co., of South Orange, N. J., to manufacture explosives; incorporators, Wm. H. Curtis, John E. Alexander and James McC. Morrow; capital stock, $100,000. Buda Iron Works, of Buda, Ill.; to manufacture railway supplies and architectural iron work; incorporators, M. J. Knipple, A. J. Fisher and S. Toomey; capital stock, $24,000. Denver Steel Co., of Denver, Ill.; to operate Bessemer steel works; incorporators, John Evans, I. H. Moffat, J. B. Grant; capital stock, $5,000,000.

Metal Market Prices.—*Rails.*—New York: $29 to $30 old rails, $22.50 for iron and $18 for steel. Pittsburg: $26.50 to $27; old rails, $25 to $27 for iron, and $17 to $17.50 for steel. Chicago: $30 to $31.50; old rails, $23 for iron and $14 to $18.50 for steel.

Foundry Pig Iron.—New York: $14 50 to $17.50. Pittsburg: $15.50 to $16.75; Chicago: $14 to $15.50.

Track Materials.—New York: steel angle bars, $1.75 to $1.90; spikes, $2 to $2.10; track bolts, 2.7 to 2.8 cts. with square, and 3.10 to 3.15 cts. with hexagon nuts. Pittsburg: splice bars, 1.95 to 2 cts. for iron, 2 to 2.1 cts. for steel; iron or steel spikes, 2.1 cts.; iron track bolts, 2.9 with square, and 3 cts. with hexagon nuts. Chicago: splice bars, 1.95 to 2.05 cts. for iron and 2.15 to 2.25 for steel; spikes, 2.15 to 2.20 cts.; track bolts, 3.05 cts. with hexagon nuts.

Pipe.—Cast iron, $27 to $30 per ton. Wrought iron, discounts as follows, at Pittsburg: 47½ and 40 per cent. on black and galvanized butt-welded; 60 and 47½ on black and galvanized lap-welded. Casing, 50 per cent.

Lead.—New York, 4.45 to 4.55 cts. Chicago, 4 45 cts. St. Louis, 4.37 cts.

Structural Material.—New York: beams, 3.1 cts.; channels, 3.1 cts.; angles, 2.05 to 2.10 cts.; tees, 2.6 to 2.75cts.; sheared iron plates, 2.20 to 2.25 cts.; steel plates, 2.25 to 2.30 for tank, 2.55 to 2.65 cts. for shell, 2.85 to 3 cts. for flange, 3.75 to 4.25 cts. for firebox. Pittsburg: beams, 3.1 cts.; channels, 3.1 cts.; angles, 2.25 cts.; tees, 2.85 cts.; universal iron mill plates, 2.25 cts.; sheared steel bridge plates, 2.45 cts.; refined bars, 1.9 to 1.95 cts.; steel plates, 2.35 cts. for tank, 2.70 cts. for shell, 2.90 cts. for flange, 4.25 to 4.50 cts. for firebox. Chicago: beams, 3.2 cts.; channels, 3.2 cts.; angles, 2.25 to 2.35 cts.; tees, 2.9 to 3 cts.; universal plates, 2.3 to 2.4 cts.; sheared plates, 2.5 to 2.6 cts. for iron and 2.6 to 2.7 cts. for steel; steel plates, 2.8 ot 2.9 cts. for tank, 3.25 cts. for shell, 3.5 cts. for flange, 4.25 to 5.5 cts. for firebox; boiler rivets, 4 to 4.25 cts.